



AUGUST 2013

# Environmental Impact Statement. Additional Offshore Oil and Gas Exploration Drilling in Block 2, Tanzania

## Volume I Main Report

FINAL

### **PROPONENT**

Statoil Tanzania AS  
P.O. Box 713,  
79 Haile Selassie, Oysterbay  
Dar es Salaam  
Tanzania

### **SUBMITTED FOR APPROVAL TO:**

National Environment Management Council  
Migombani Street Plot 29/30  
Regent Estate, Mikocheni  
P.O. Box 63154  
Dar es Salaam, Tanzania  
Tel: +255 22 2774852/4889  
Email: dg@nemc.or.tz  
21st August 2013

### **PREPARED BY:**

COWI Tanzania.  
398 Kawawa Road  
PO Box 1007  
Dar es Salaam, Tanzania



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STATOIL

# Environmental Impact Statement. Additional Offshore Oil and Gas Exploration Drilling in Block 2, Tanzania

## Volume I Main Report

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## ABBREVIATIONS AND ACRONYMS

BG:	British Gas Group
BOD:	Biological Oxygen Demand
BOP:	Blow-Out Preventer
CBD:	Convention on Biological Diversity
CH <sub>4</sub>	Methane
CO:	Carbon Monoxide
COD:	Chemical Oxygen Demand
CO <sub>2</sub> :	Carbon dioxide
CSR:	Corporate Social Responsibility
DMI:	Dar es Salaam Maritime Institute
DREAM:	Dose related Risk and Effect Assessment Model
DSFA:	Deep Sea Fisheries Authority
DST:	Drill Stem Test
DWH:	Deepwater Horizon
EACC:	East African Coastal Current
EEZ	Exclusive Economic Zone
EIA:	Environmental Impact Assessment
EIS:	Environmental Impact Statement
EMA	Environmental Management Act
ERP:	Emergency Response Plan
ESIA:	Environmental and Social Impact Assessment
ESMaP:	Environmental and Social Management Plan
HIV/AIDS	Human immunodeficiency virus infection / acquired immunodeficiency syndrome

HOCNF	Harmonised Offshore Chemical Notification Format
H&S	Health and Safety
HSE:	Health Safety and Environment
IBA	Important Bird Areas
ILO:	International Labour Organisation
IMT:	Incident Management Team
ITCZ	Inter-Tropical Convergence Zone
IUCN:	International Union for Conservation of Nature
JIT	Joint Industry Project
Klif	The Norwegian Climate and Pollution Agency
LDCs	Least Developed Countries
LGA	Local Government Authority
LNG:	Liquefied Natural Gas
MARPOL:	Marine Pollution (International Convention for the Prevention of Pollution from Ships)
MBREMP:	Mnazi Bay-Ruvuma Estuary Marine Prk
MEG	Mono Ethylene Glycol
MIMP:	Mafia Island Marine Park
MMO	Marine mammal observer
MPA:	Marine Protected Area
MRCC:	Marine Rescue and Coordination
MSDS:	Material Safety Data Sheets
MUFA:	Multiple Use Facility Agreement
NADF:	Non-Aqueous Drilling Fluid
NEMC:	National Environment Management Council
NEP	National Environmental Policy

NGO	Non-Governmental Organisation
NMOSRCP:	National Marine Oil Spill Response Contingency Plan
NO <sub>x</sub> :	Nitrogen Oxide
NMVOC:	Non-methane volatile compounds
OBM:	Oil-Based Mud
OCNS:	Offshore Chemical Notification System
OIM	Offshore Installation Manager
OSHA	Occupational Safety and Health Authority
OSRP:	Oil Spill Response Plan
OSPAR:	Oslo- Paris Convention
PEC:	Predicted Environmental Concentration
PEL:	Probable Effect Level
PIL	Pacific International Lines
PLHAs	Persons Living with HIV and AIDS
PLONOR:	Pose Little or No Risk to the Environment
PNEC:	Predicted No Effect Concentration
PPE:	Personal Protective Equipment
PSA:	Product Sharing Agreement
PTA:	Permanent Threshold Shift
QA	Quality Assurance
ROV:	Remote Operated Vehicle
RAMSAR	Convention: The Convention on Wetlands
SBS:	Supply Base Solutions
SEC:	Southern Equatorial Current
SERPENT:	Scientific and Environmental ROV Partnership Using Exiting Technology

SO <sub>2</sub> :	Sulphur dioxide
SOBM:	Synthetic Oil Based Mud
SOLAS:	Safety of Life at Sea
SUMATRA:	Surface and Marine Transport Regulatory Authority
TACMP	Tanga Coelacanth Marine Park
TARIFI	Tanzania Fisheries Research Institute
TBS:	Tanzania Bureau of Standards
TCC:	Thermo mechanical Cuttings Cleaner
TD:	Target Depth
TANSEA:	Tanzanian Sensitivity Atlas
TOC:	Total Organic Carbon
TPA	Tanzania Ports Authority
TTS:	Temporary Threshold Shift
TPDC:	Tanzanian Petroleum Development Cooperation
UNESCO	United Nations Educational, Scientific and Cultural Organization
VETA:	Vocational Education Training Authority
VMS:	Vessel Monitoring System
VPO	Vice President's office
WBM:	Water Based Mud
WIOMSA:	Western Indian Ocean Marine Science Association
WWF:	World Wildlife Foundation
ZMA:	Zanzibar Maritime Authority

# 1 EXECUTIVE SUMMARY

## 1.1 Title and location of the project

Project title                      The project title is: " *Additional offshore Oil and Gas Exploration Drilling in Block 2, Tanzania* "

## 1.2 Proponent and consultant conducting the EIA

Proponent                              The proponent for project is Statoil Tanzania Limited, a Tanzania-registered company engaged in oil and gas exploration.

Consultant                              The EIA was conducted by COWI Tanzania, a Tanzania-registered consulting company.

## 1.3 Project description

The objective of the exploration drilling programme is to determine the presence and quantities of hydrocarbon reserves (oil or gas) in (Block 2) off the coast of Tanzania, where Statoil is the operator. Statoil's concession in Block 2 starts approximately 20 km and ends approximately 240 km from the mainland coast off Lindi District/Lindi Region.

### 1.3.1 Background for the Project

In 2007, Statoil signed a Production Sharing Agreement (PSA) for Block 2 offshore oil and gas exploration zone with the Tanzanian Petroleum Development Cooperation (TPDC). Statoil has delimited three subareas in Block 2 in which prospects are identified or will most likely be identified: i) Sea Gap, ii) West Side and iii) Davie Ridge (Figure 1-1). Exploration wells have already been drilled at Zafarani, Lavani and Tangawizi reservoirs/locations in the Sea Gap area. Huge gas discoveries have been made on these three locations adding up to 15-17 trillion cubic feet (tcf) of gas in place.

Having discovered sufficient gas-volumes to initiate planning of an LNG Plant, Statoil's exploration strategy is now to identify further discoveries to increase gas volumes to sustain a robust resource base for the LNG-development. Therefore some more prospects to be drilled within Block 2 have been identified. Drilling of production wells to produce the gas will be covered by a separate EIA-process that will be linked to development of the LNG-project.

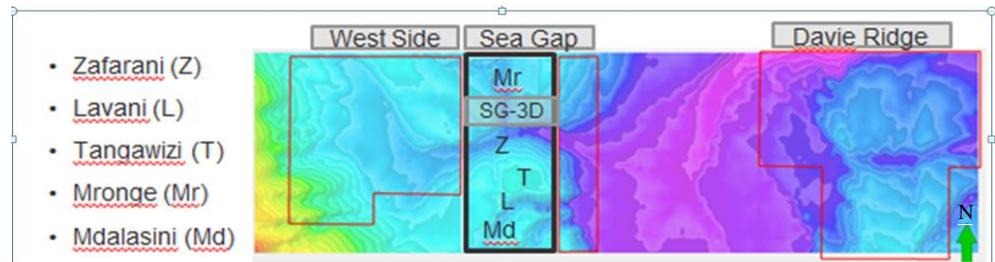


Figure 1-1 Overview of the three areas in Block 2. (Source: Statoil)

### 1.3.2 Planned wells

The project involves the drilling of several deep-water offshore exploration/appraisal wells in Block 2.

Within the Sea Gap area, Statoil have identified new prospects (Figure 1-1). The drilling campaign is planned to be started in late August or beginning of September. Mronge is the first well planned to be drilled. After Mronge, a Drill Stem Test on Zafarani-2 is planned. Several additional exploration and appraisal wells will be drilled in the Sea Gap Area. Including potential pilot holes. A pilot hole for Zafarani 3 is already planned for.

In addition some exploration wells in the Western Area and in Davie Ridge will be drilled based on the 3D seismic survey that Statoil conducted recently. The exact location of these well can be to some extent changed due to updated information.

All these wells will be drilled at a water depth of 2,100 - 3,000 meters with a drill ship specialized for ultra-deep water to a well target depth (TD) of over 3000 meters below sea bed.

For some wells, a pilot hole may be needed before drilling the top hole section in order to assure high quality log data from the shallow section, and to reveal presence of pockets of gas or water under pressure.

The exploration drilling campaign is expected to last until end of 2015, but can be extended to 2016 depending on the outcome of drilling activities.

### 1.3.3 Operation

#### Drilling

Exploration drilling will be conducted using a Dynamically Positioned drill ship. Top-hole sections of the wells (upper 400-600 m) will be drilled with sea water and sweeps and/or water-based mud (WBM). The bottom hole sections will be drilled with synthetic oil-based drilling mud (SOBM).

During the drilling of the Top-hole sections non-toxic drill cuttings and Water Based Muds (WBM) will be discharged directly on the seabed in the near proximity to the well according to normal practice. The lower sections of the well will be drilled with synthetic oil based mud (SOBM). Cuttings and SOBM are circulated to the drill ship where cuttings are removed from the drilling mud in the solid control system and discharged to the sea. The cuttings will be cleaned in the centrifuge/cuttings dryer and when discharged if the content of oil on the cuttings are less than 6.9%. However, the system usually delivers 3-5% oil content. Recent operations indicate in the range of 3-4 % The SOBM that is planned to be used will be of low ecotoxicity to minimize environmental impacts. The SOBM is formulated with organic base oil from which aromatic components have been removed. The resulting mixture is thus of low toxicity, highly biodegradable and approved for offshore drilling throughout the world.

#### Drill Stem Test

A Drill Stem Test (DST) is planned for the Zafarani-2 well. A DST is a procedure used to determine the detailed composition of the fluids, the productive capacity and the permeability of a hydrocarbon reservoir zone. In the future it is assumed that a DST of Tangawizi 3 (which is an appraisal well) will be done and potentially an appraisal well in the areas Davie Ridge and Western Area if any discoveries here.

#### Support facilities

Mtwara Port will operate as base port for the operations providing necessary services and facilities. Two support vessels will provide regular to-and-from service between the drill ship and Mtwara Port to supply the drill ship with drilling chemicals, materials and provisions and to transport wastes from the drill ship. Personnel will be transferred to the drill ship by helicopter from Dar es Salaam Airport.

#### Waste Management

All other waste solid than the cuttings will be transported to land, temporarily stored at the Mtwara base and transported to the Mdenga Waste Management site in Mtwara before Statoil's onshore waste management contractor will handle the waste.

All activities involved in Statoil's Block 2 well exploration programme will be conducted according to international best practice standards and conventional exploration well drilling scheduling and procedures. The wells will be drilled and constructed using materials of the best international standards.

## 1.4 Scope of the EIS

The EIS include the assessment of impacts of exploration drilling in the entire Block 2 area including the three subareas:

- › Sea Gap (where drilling has taken place);
- › West Side (where drilling has not be carried out so far) and
- › Davie Ridge (where drilling has not be carried out so far).

The EIS has been based on assessments of the exploration drilling of the next planned well and extrapolation of the impacts of one well to assess the possible cumulative effects of future planned and not yet planned exploration drilling operations in Block 2.

## 1.5 Project environment

The exploration area in Block 2 is distant from socially, economically and from a conservation perspective sensitive and important environmental resources of Tanzanian coastal areas. The nearest Marine Protected Area (Mafia Island Marine Park) is approximately 140 km north of Block 2.

### 1.5.1 Environment in Block 2 area

#### Surface waters in Block 2

Plankton and pelagic fish

There is a summer bloom of phytoplankton in the Block 2 area caused by the upwelling of nutrients from the deep, which forms the basis of production of zooplankton and pelagic fish species including commercially important species like Yellowfin -, Skipjack- and Bigeye tuna that form the basis for offshore deep fishing by foreign vessels.

Marine Turtles

Endangered marine turtles listed on the IUCN Red list including Loggerhead-, Olive Ridley-, Leatherback-, Green- and Hawksbill Turtles may occasionally pass through Block 2.

Dolphins and Whales

This also goes for dolphins and whales. Spinner Dolphin is the most abundant species, followed by Spotted- and Rissos Dolphin. Occasionally Humpback Whale and Sperm Whale are observed. These species are listed as vulnerable on the IUCN Red List.

Seabirds

Very few seabirds are observed in the area. However, species like Masked Booby, Swift Tern and Common Noddy, that roost and nest on offshore Islands like Latham Island north of Mafia Island or islands to the south in Mozambique, are known to feed far offshore. These species may occasionally be observed in Block 2.

#### Seabed in Block 2

The seabed environment in Block 2, with water depths mainly ranging between 1700 and 3300 m, is typical of deepwater ecosystems around the world - completely dark and very cold, with temperatures about 2-5 °C.

Seabed sediment	The seabed sediment consists of fine grained deep-sea ooze, of which more than 30% are dead microscopic pelagic organisms, primarily exoskeletons of coccolithopores that have sunk and settled on the seabed after death.
Benthic invertebrate fauna	There is no visible light at depths below 200 m and below 1000 m depth all traces of light are absorbed. Consequently, no photosynthesis takes place on the seabed in Block 2. The deep ocean floor is therefore food limited and the only input of food and energy for the deep sea organisms is dead phytoplankton and their consumers from the surface waters resulting in relatively low abundance of deep sea organisms compared to shallower waters. However, the diversity of life in the deep sea can be extremely high. The deep sea megafauna in the area is dominated by xenophytophores, echinoderms and sponges (Porifera). The abundance of macrofauna is rather low and includes nematode worms, snails, foraminiferans, ostracods, polychaetes, cnidarians, sponges, bivalves, crustaceans and holothurians. The meiofauna is dominated by foraminiferans and nematodes.
Benthic fish	A total of 10 different species of deep-sea benthic fish has been observed in the area.

#### Commercial activities in Block 2

Commercial shipping and industrial fishing use the waters in Block 2. Fishing vessels include long-liners from SE Asia and purse-seiners mainly from Spain and France. The vessels are primarily fishing for Yellowfin-, Skipjack- and Bigeye tuna. However, the numbers of vessels participating in this fishery have fallen markedly in recent years, probably due to the problems with piracy along the East African Coast.

### 1.5.2 Coastal areas

Coastal areas of Tanzania are also included in the influence area of the project, mainly due to the unlikely risk that oil from an accidental oil spill or uncontrolled blow-out, may reach the coastline. Several sensitive coastal ecosystems are encountered along the Tanzanian Coast including mangrove forests, coral reefs, seagrass beds and bays and estuaries (which are important habitats for coastal birds among others).

The Block 2 project area of influence includes the Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP) that is within 10 km of the navigation route at approaches to Mtwara Port. Sensitive areas also exist at Songo Songo Archipelago, to the west of the navigation route northwards, though most of the navigation route is further than 50 km from the mainland shores of southern Tanzania.

## 1.6 Stakeholders and stakeholder involvement

### 1.6.1 Stakeholders consulted

Commencing in mid-March 2013, stakeholder consultations were conducted. The following stakeholders were consulted:

- › Ministry of Energy and Minerals
- › TPDC
- › SUMATRA
- › Tanzania Port Authority - Mtwara Port
- › Marine Rescue and Coordination (MRCC)
- › Supply Vessel (KC Tamblyn)
- › Deep Sea Fishing Authority
- › Tanzania Fisheries Research Institute
- › Department of Fisheries, Ministry of Livestock and Fisheries
- › Mtwara District Council
- › Mtwara Mikindani Municipal Council Department of Fisheries, Economic Planning and Public Health
- › Lindi District Council Department of Fisheries and Economic Planning
- › Local Fishers at Shangani (Mtwara Port)
- › Tanzania Marine Parks
- › Mnazi Bay Rovuma Marine Park
- › WIOMSA
- › Institute of Marine Sciences
- › Mtwara Port Waste Management Contractor (SBS)
- › Offshore telecommunication infrastructure - SEACOM, Zantel EASSy

At all stakeholders meetings, the representative of the project proponent presented the project in full. The stakeholders were given an opportunity to raise their concerns or comments. All concerns and comments raised were recorded and addressed during the EIA study.

### 1.6.2 Stakeholders opinions and concerns

The stakeholder consultations identified both positive opinions and negative concerns. Stakeholders had positive opinions of the project in terms of:

- › Employment opportunities;
- › Local and National economic benefits of development of gas to energy and
- › Possibilities of growth in the service industry.

Stakeholders were concerned about:

- › Pollution due to oil spills;
- › Conflict with fisheries;
- › Safety of supply vessels and
- › Waste Management issues

The opinions and concerns raised by stakeholders have been addressed as far as possible in this EIS.

## 1.7 Impacts

### 1.7.1 Environmental and social impact significance

The exploration drilling activities have been classified in positive impacts and adverse impacts. Using various criteria the significance of adverse environmental and socioeconomic impacts were grouped in the following categories:

- › i) no impact
- › ii) insignificant impact,
- › iii) minor impact
- › iii) moderate impact and
- › iv) major impact.

Impacts were assessed for each of the four project phases:

- › The site selection and design phase;
- › The mobilization/site preparation phase;
- › The operation (well-drilling and drill stem test) phase and
- › The decommissioning phase.

Planned normal operations	All planned normal operations were assessed to have negative, temporary environmental impacts, but were assessed to be " <i>insignificant</i> ". A few of the planned operations were assessed to cause " <i>minor</i> " impacts.
Unplanned events or accidents	<p>The impacts of unplanned events/accidents may be more severe. The impact analysis showed that:</p> <ul style="list-style-type: none"> <li>› The potentially most severe impacts are impacts in connection with the unlikely event of a blow out of oil which is assessed potentially to cause negative, temporary "<i>major impact</i>" on most environmental and socio-economic features. However, the wells drilled so far at Block 2 have only proved gas. This also applies for all other offshore wells drilled in Tanzania. The first well drilled by Statoil (Zafarani 1) could though potentially have oil, and the EIS for the Zafarani-structure thus included an Oil Spill Response Plan. No oil is expected for the coming wells to be drilled in Block 2. If analysis for any future wells indicates more than 1% probability for oil, an OSRP for that well will be established including necessary oil spill equipment. In that case, NEMC and SUMATRA will be notified and involved to the degree deemed necessary. Although the future wells are not expected to include any oil, a general discussion about oil spills from blow-out are included in this EIS as the scenario cannot be completely ruled out for prospects on the not yet explored areas as Davie Ridge and West Side.</li> <li>› Accidental spills of diesel from drill ship or supply vessels may potentially cause "<i>moderate</i>" negative, temporary impacts on some marine organisms and ecosystems;</li> <li>› Blow-out of gas has been assessed potentially to cause "<i>moderate</i>" to major impacts on some marine organisms and ecosystems.</li> </ul>

### 1.7.2 Environmental risk

By environmental- and socio-economic risk is understood the combination of the significance of an impact and the probability that an impact actually may occur. Using various criteria environmental risks have been grouped in the following categories:

- › i) no risk ,
- › ii) negligible risk,
- › iii) low risk,
- › iv) significant risk and
- › v) high risk.

Environmental risks Impacts were assessed for each of the four project phases:

Planned normal operations

The environmental risks of all planned normal operations are "*negligible*" on environmental features that may be affected.

Unplanned events or accidents

Environmental risks of unplanned events/accidents range from "*negligible risk*" to "*minor risk*" for those features that may be affected. The environmental risk assessment has shown that the potentially largest risks are impacts in connection with the unlikely event of a blow out or large accidental spills of diesel.

## 1.8 Cumulative effects

Cumulative effects caused by exploration drilling include the combined effects of exploration drilling plus the effects of other activities in the influence area, including fishing and shipping. The planned operations during the drilling and drill stem test operations will not contribute to measurable or observable cumulative effects i.e.

- › The drilling operations will cause some disruption on benthic fauna through smothering by cuttings and mud components within a tiny area of 30-140 m from the well. This is the only activity that may affect the benthic fauna. Long-line fishing or purse seine fishing for tuna in the surface water and shipping are the only other human activities in the area and they do not affect the seabed;
- › Noise from the drill ship and supply vessels may cause avoidance reactions among dolphins or whales crossing the area. The incremental sound made by supply boats and the drill ship would not add significantly to existing ambient noise levels in the primary impact area.
- › Emissions to the air during drilling will not reach inhabited areas and thus not contribute to cumulative effects of air pollution and
- › Garbage will not be discharged and will thus not contribute to cumulative impacts. This is also the case for wastewater, which is treated onboard the drill ship before discharge;

The unlikely event of a blow- out of oil may cause cumulative effects on:

- › Corals that in some areas are already impacted by bleaching due to temperature rise during occurrence of El Nino or by dynamite fishing, sedimentation or pollution;
- › Mangroves that in some areas are severely affected by overharvesting of firewood, charcoal, timber etc., construction of evaporation ponds for solar salt production and large scale conversion to build ports, urban settlements, industries etc. and
- › Seagrass beds that in some areas are impacted by excessive sedimentation from land based activities

## 1.9 Alternatives considered

The EIS report discusses and concludes on the alternative options and technologies the most significant being:

- › No alternatives exist to confirm the presence of hydrocarbon reserves other than through drilling. Extensive analysis of seismic data leads to the choice of the best location, which for Block 2, provides no reason to re-locate;
- › Equipment, well design and materials for drilling are selected to reduce possibility of risk from equipment or chemical mixture failure:
  - › The choice of a dynamic positioned deepwater drill ship is the best solution for this environment due to the high ocean currents in the area;
  - › The wells will be drilled by vertical drilling which is simpler and safer than directional drilling which is significantly more challenging and expensive.
- › Treatment of cuttings including a TCC-unit onshore or offshore and transporting cuttings to shore for treatment and disposal is discussed in the EIS as an option to the solid control system onboard the drill ship.
- › Mtwara Port is the best choice of base port solution for the drilling operations mainly because:
  - › Mtwara is the closest port to the planned explorations in Block 2, reducing costs of fuel and time;
  - › Mtwara has already been rehabilitated to support offshore exploration drilling with storage areas, freshwater supply, and an operational Mud Plant for processing the drilling muds;
  - › TPDC has urged all operators to utilise Mtwara Port.

Navigation routes for support vessels and helicopters to and from Block 2 to Mtwara Port and Dar es Salaam International Airport, respectively, minimize travel time and costs, as well as potential impacts to the environment.

## 1.10 Mitigating measures

Discussion and proposals for mitigating measures to avoid or minimize environmental and social impacts has focussed on:

- › Mitigating measures for accidental spills from ship/vessels;
- › Mitigating measures for blow-out;
- › Mitigating measures for the risk of introduction of invasive species via ballast water if ships arriving from outside the East African region;

- › Slop treatment;
- › Mitigating measures for the discharge of cuttings with adhered SOBMs components;
- › Waste Management onboard ships and on land and
- › Occupational Health and Safety policies, procedures and training programs ,which is implemented on all Statoil's operations and at service providers and which includes:
  - › The provision of PPEs;
  - › Appropriate signage of dangers and cautions;
  - › Adequate labelling of hazardous materials and
  - › Procedures for the storage and handling of hazardous materials.

### 1.11 Environmental and Social Management Plan

An Environmental and Social Management plan will be implemented to ensure that potential impacts are avoided or minimized and that environmental risks are reduced to as low as possible. The plan consists of the following sub-plans and policies:

- › SBS Waste Management Plan for treating waste at Mdenga, Mtwara;
- › Waste Management Plan/Procedures for the drill ship;
- › Emergency Response Plans;
- › Health Safety & Environment Policy;
- › Health and Safety Manual and
- › Chemical management procedures.

### 1.12 Auditing and Monitoring Plan

An auditing and monitoring plan for the drilling operations are outlined in the report focusing on:

- › Audits and inspections;
- › Inventorying of drilling wastes and other types of waste;
- › Monitoring of water quality of discharges (hydrocarbon levels) and

- › Logging of non-routine events, spills and accidents throughout drilling operations and analysis causes

## 1.13 Cost benefit analysis

### 1.13.1 Costs

The costs of the additional exploration drillings include:

- › **Investment costs** which for each well in Block 2 is estimated to be in the order of US Dollars 130-150 million;
- › **Environmental costs** are mainly related to Waste Management and HSE procedures.
- › **Social costs** of potential impacts during planned operations are negligible. The financial resources needed to mitigate the impacts from planned activities are minimal in comparison to the investment costs. Large socio-economic costs are only expected in case of the unlikely event of blow out or accidental spillage occurs. These costs will be related to:
  - › Impacts on economic activities such as fisheries, tourism and shipping;
  - › Injury or more severe fatalities to crew and compensation to be paid;
  - › The economic cost of operational down time depending the severity of the damage to the vessel(s) and
  - › Any damages to the drill ship or supply vessels caused by immense pressure or fire that have to be repaired or re-built.

### 1.13.2 Benefits

Benefits include:

- › **Environmental benefits.** The project has a number of environmental benefits:
  - › Gas developed and brought into Tanzania will have some environmental benefits as it may reduce the need for woods that cause deforestation etc.;
  - › Statoil have already invested in surveys and studies (example SERPENT-surveys and TanSEA) that have provided valuable information on Tanzania's coastal and marine environment and geology. This information is not only beneficial for Statoil but has also been made available to others to improve environmental management and monitoring of sensitive areas.

- › **Socio-economic benefits.** The immediate socio-economic benefit from additional exploration drillings is employment and the procurement of local supplies and services. This will contribute positively to the local economy in Mtwara and Tanzania as a whole.
- › **Long term benefits** to the country are the development of discovered gas into energy. The availability of gas for energy will have a multiplier effect in the growth of industry. The improved energy supply will also benefit businesses and households. Furthermore, the government will earn income from any gas exported to other countries.

## 1.14 Decommissioning

The EMA of 2004 requires that the operator shall undertake safe decommissioning, site rehabilitation and ecosystem restoration required before the closure of the project, at own cost. Drilling will cease when the well target depth (TD) is reached. The following measures will be taken:

- › The wells will be logged, and the coring may be undertaken. After completion, the wells may be plugged and abandoned. The BOP will be removed but the wellhead will remain on the sea floor. In some instances the wells may be temporarily plugged for later re-entering and conversion to production wells;
- › After completion of the abandonment procedures, the remote-control operated vehicle (ROV) will survey the seafloor to make sure that no unnecessary structure from the drilling and abandonment activity is left behind;
- › The drill ship will leave the location and all vessel transport related to the drilling will cease and
- › Disposing of all waste generated during last few weeks of operation.

## 1.15 Conclusion

With the management strategies that will be employed by Statoil for the Block 2 drilling programme, any health or safety and environmental effects of the proposed exploration drillings are expected to be negligible, temporary and localised.

## 2 INTRODUCTION

COWI Tanzania Ltd has been commissioned to carry out an Environmental Impact Assessment of further offshore exploration drilling prospects in Block 2 on behalf of Statoil Tanzania.

The EIA study was carried out during the period 11. March – 31 May 2013.

### Legislative requirements

This is based on the national legislative requirements under the Environmental Management Act, Cap 191 and the subsequent Environmental Impact Assessment (EIA) and Audit Regulations, 2005, that requires a proponent of any development project to apply for an environmental certificate in the format given by the National Environment Management Council (NEMC). The proponents are required to prepare and forward:

- › A Project Brief
- › A Scoping Report and
- › An Environmental Impact Statement report (EIS report)

A Project Brief for the project was forwarded to NEMC on 11. March 2013, a screening decision letter from NEMC dated 27 March 2013 was received on 24 April and a Scoping Report was forwarded to NEMC on 25 April 2013. A NEMC Scoping report letter was received on 15 May 2013.

This report is Volume I of the EIS report for the project. A separate Volume II contains all Appendices for the report.

### Scope of the EIS

The EIS include the assessment of impacts of exploration drilling activities ( exploration/appraisal wells and sufficient testing of any discoveries as needed) in the entire Block 2 area including the three subareas:

- › Sea Gap (where drilling has taken place)
- › West Side (where drilling has not be carried out so far) and
- › Davie Ridge (where drilling has not be carried out so far)

### 2.1 Background for the Project

In 2007, Statoil and Exxon signed a Production Sharing Agreement (PSA) for Block 2 offshore oil and gas exploration zone with the Tanzanian Petroleum Development Cooperation (TPDC). Exxon holds 35% of the interests in Block2. Statoil, which is the operator on behalf of TPDC, holds 65%.

The exploration drilling for oil and gas in Block 2 aims to identify the presence of hydrocarbons in the geological strata target identified from seismic surveys.

Drilling operations carried out so far

Deep-water offshore exploration wells have already been conducted at Zafarani, Lavani and Tangawizi reservoirs/locations at the Zafarani-structure and have received either Environmental Certificate (no EC/EIS/496 issued 23rd November 2011) or Variation Certificates from the Vice President's Office-Division of Environment. During 2012 and until date the following exploration operations were completed in Block 2:

- 1 Drilling of Zafarani-1 including a side step ;
- 2 Drilling of Lavani-1;
- 3 Drilling of Lavani-2;
- 4 Drilling of Zafarani-2
- 5 Drilling of Tangawizi-1;

In addition to the exploration drilling, a seabed sampling survey and a 3D seismic survey have been undertaken in Block 2 during 2012.

Huge gas discoveries have been made on these three locations adding up to 15-17 trillion cubic feet (tcf) of gas in place.

Having discovered sufficient gas-volumes to initiate planning of an LNG Plant, Statoil's exploration strategy is now to identify further discoveries to increase gas volumes to sustain a robust resource base for the LNG-development. Therefore some more prospects to be explored within Block 2 have been identified. Future drilling of production wells to produce the gas will be covered by a separate EIA-process that will be linked to development of the LNG-project.

The project covered by this EIS consists of an exploration drilling campaign which includes various drilling exploration activities within Block 2. The EIS describes the planned drilling activities as far as the details are known at the time when issuing the EIS document. If any changes to these plans will be made that introduces any new impacts or changes in the impact level in the impacts described in the EIS-document, NEMC will be notified through a letter as soon as these potential changes are identified so any updates of the EIS report can be done according to what is needed.

## 2.2 Nature of the project

Projects of this nature fall under Type A activities under the First Schedule of the EIA and Audit Regulations of 2005 item 8 (i) "*oil and gas field exploration and development*". According to the regulations, projects of this nature require an Environmental and Social Impact Assessment (ESIA) and the compilation of an EIS report.

## 2.3 Structure of the EIS Report

This EIS report is structured as follows:

- › **Chapter 3** contain a description of the project in terms of location and activities to be undertaken during the four project phases i) Site selection and design phase, ii) mobilization phase, iii) operation (Well-drilling) phase and iv) the decommissioning phase. Project Alternatives are also discussed in this Chapter;
- › **Chapter 4** outlines the policy, legal and institutional framework in terms of i) relevant national legislation and policies, ii) international agreements and conventions and ii) institutional aspects to consider;
- › **Chapter 5** describes existing environmental and socioeconomic conditions that are particularly relevant for the EIS;
- › **Chapter 6** presents the outcome of stakeholder consultations in terms of stakeholders identified and consulted, the stakeholders opinion of the project and outline of the addressing of the stakeholders opinions and concerns in the EIS;
- › **Chapter 7** includes the assessment of environmental and socioeconomic impacts of the drilling activities during the four project phases i) Site selection and design phase, ii) mobilization phase, iii) operation (Well-drilling) phase and iv) the decommissioning phase that have been identified during the scoping exercise. The chapter also addresses cumulative impacts;
- › **Chapter 8** describes environmental and social mitigation measures for the three project phases i) Mobilization Phase, ii) Operation (Well-drilling) Phase and iii) Decommissioning Phase;
- › **Chapter 9** presents the Environmental and Social Management Plan including Statoil's project team, the drilling contractor and the waste management contractor;
- › **Chapter 10** presents the Environmental and Social Monitoring Plan;
- › **Chapter 11** presents the results of a cost Benefit Analysis;
- › **Chapter 12** presents the Decommissioning Plan;
- › **Chapter 13** contains the summary and conclusion section and
- › **Chapter 14** is a reference list

## 3 PROJECT DESCRIPTION

### 3.1 Location of the Project

Figure 3-1 shows the locations of concession Blocks in Tanzania and the companies that have been granted these concessions.

Statoil's concession in Block 2 starts approximately 20 km and ends approximately 240 km from the mainland coast of Tanzania, and stretches beyond the Tanzanian continental shelf. Block 2 contains no islands or tidal land and the closest land to the well locations is Mchinga Village in the Lindi District.

#### Subareas of Block 2

Within Block 2, Statoil has delimited three subareas in which prospects are identified or most likely will be identified (Cf. Figure 3-2):

- › Sea Gap
- › West Side
- › Davie Ridge

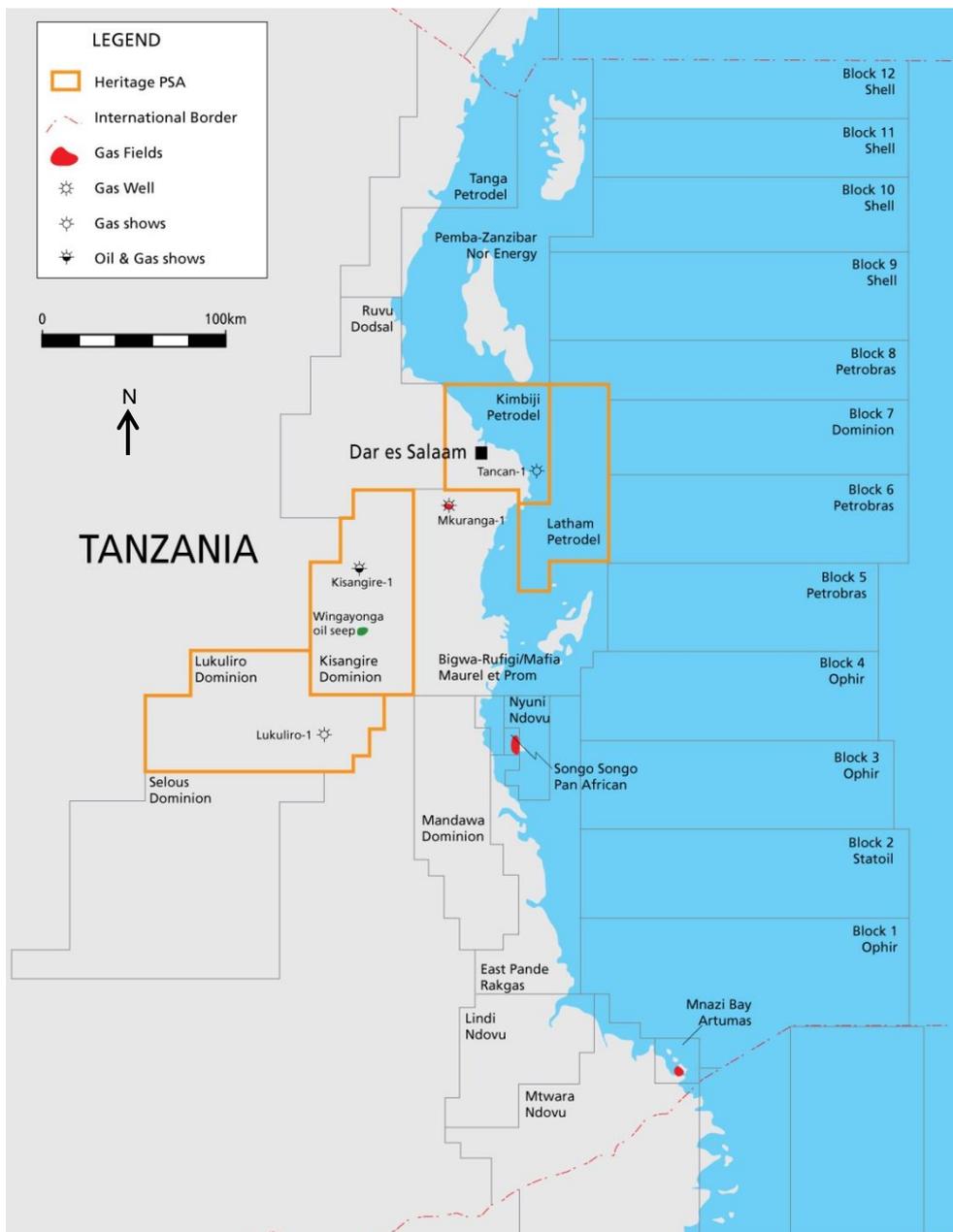


Figure 3-1 Location of concession Blocks in Tanzania. Please note that BG has taken over from Ophir in Block 1,3 and 4. (Source Statoil)

### 3.2 Project phases

The drilling of a well includes the following phases:

- › Design and sites selection phase;
- › Mobilization phase,
- › Operation (Well-drilling) phase and
- › Decommissioning phase

### 3.3 Site selection and design phase

#### 3.3.1 Site selection

The project involves the drilling of several deep-water offshore exploration/appraisal wells in Block 2.

Table 3-1 describes the wells that are identified and thus planned to be drilled within the drilling campaign included into this EIS, their location (coordinates and ref. maps) and their key characteristics. Maps of the locations of the wells are



shown in Figure 3-4 and Figure 3-5. Any Drill Stem Tests will be based on the outcome of the result of the drilling, hence it is difficult to predict. Based on the existing drilling, a DST of Zafarani 2 is decided. Further it is assumed that a DST of Tangawizi 3 (appraisal well) will be done and potentially an appraisal well in the areas Davie Ridge and Western Area if any discoveries here.

For some wells, a pilot hole may be needed before drilling the top hole section, in order to assure high quality log data from the shallow section, and to reveal presence of pockets of gas or water under pressure.

The drilling campaign is planned to be started in late August or beginning of September. Mronge is the first well planned to be drilled. After Mronge, a Drill Stem Test on Zafarani-2 is planned. Several additional exploration and appraisal wells will be drilled in the Sea Gap Area including potential pilot holes. A pilot hole for Zafarani-3 is already planned for.

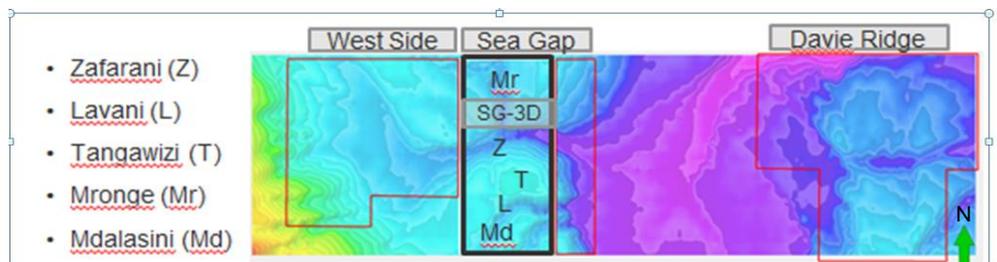


Figure 3-2 Overview of the prospects in Block 2. (Source: Statoil).

Later several additional exploration and appraisal wells will be drilled in the Sea Gap Area. In addition some exploration wells in the Western Area and in Davie Ridge will be drilled based on the 3D seismic survey that Statoil conducted recently. (Cf. Table 3-1). The exact location of these well can be to some extent changed due to updated information.

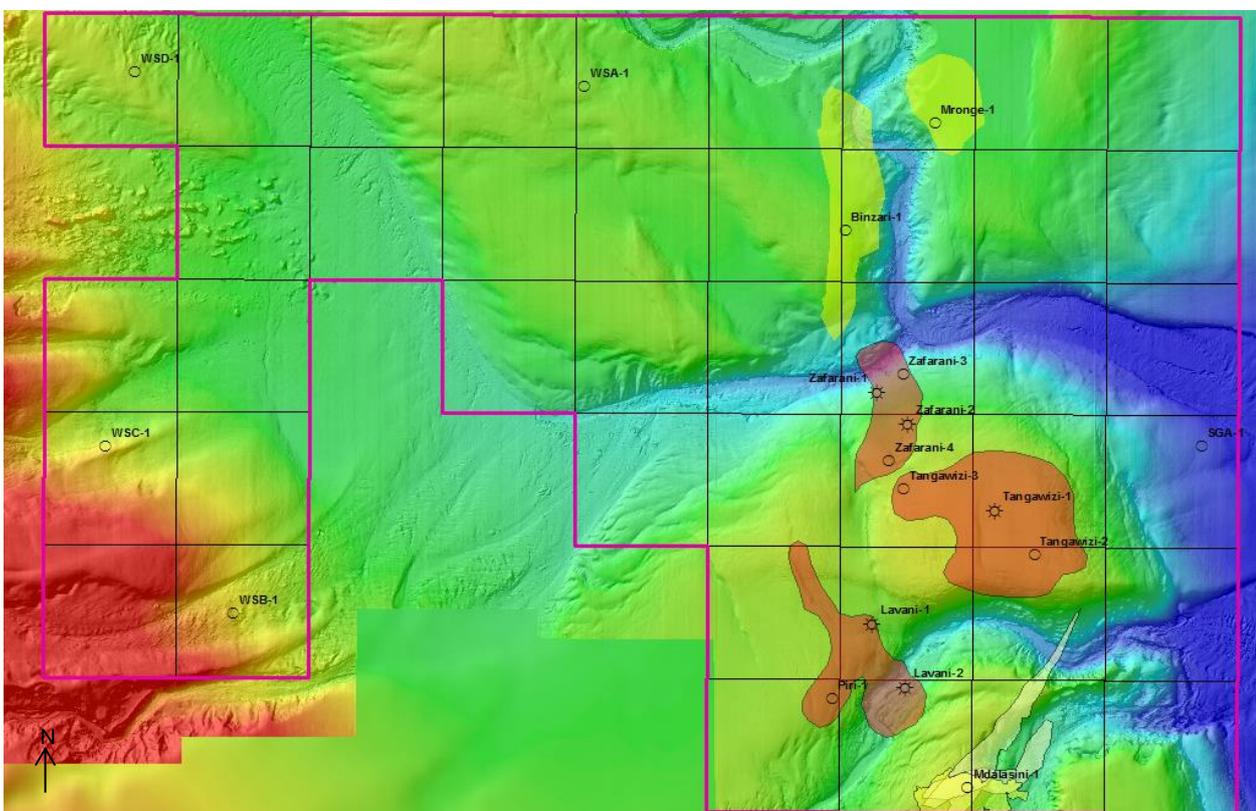
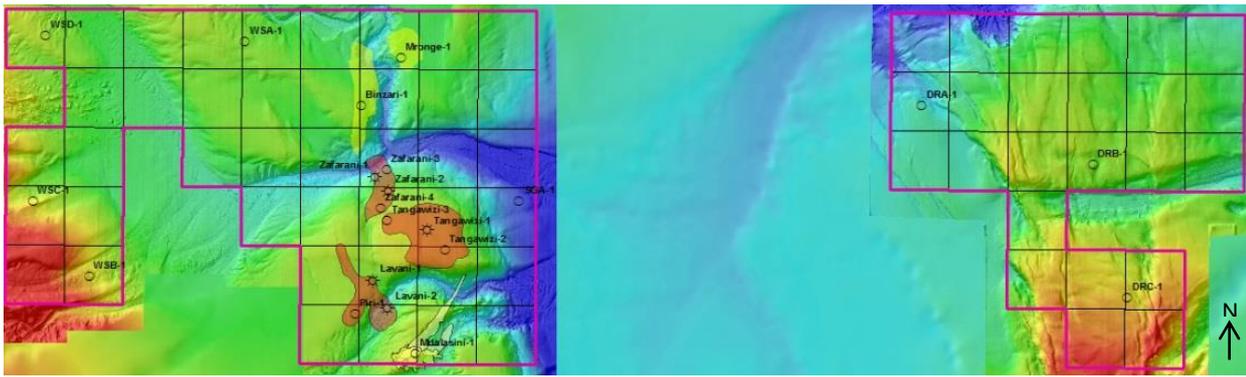
The wells will be drilled at a water depth of 2,100 - 3,000 meters with a drill ship specialized for ultra-deep water to a well target depth (TD) of over 3000 meters below sea bed.

The exploration drilling campaign is expected to last until the end of 2015, but can be extended to 2016, depending on the outcome of the drilling activities.

*Table 3-1 Possible future exploration and appraisal wells that are planned to be drilled in Block 2*

Area	Prospect	Water depth (m)	Target depth (m)	Coordinate
SeaGap	Mronge-1	2500	5700	40.476043 E 9.067152 S
Exploration wells Wildcats	Piri-1	2400	5600	40.412391 E 9.428188 S
	Binzari-1	2500	5000	40.41968 E 9.134237 S
	Mdalasini-1	2300	4500	40.497596 E 9.483849 S
	SGA-1	2900	5200	40.643483 E 9.268915 S
SeaGap	Zafarani-3	2600	4200	40.456443 E 9.224514 S
Appraisals wells	Zafarani-4	2400	4200	40.447564 E 9.278803 S
	Tangawizi-2	2300	2800	40.539156 E 9.337292 S
	Tangawizi-3	2300	2800	40.456741 E 9.29685 S
Western Area	WSA-1	2400	3000	40.255585 E 9.044412 S
	WSB-1	2100	3300	40.036125 E 9.37637 S
	WSC-1	2100	3300	39.955973 E 9.271411 S
	WSD-1	2300	6000	39.973541 E 9.036226 S
Davie Ridge	DRA-1	3000	6000	41.211092 E 9.130281 S
	DRB-1	2800	4500	41.453929 E 9.212784 S
	DRC-1	2600	7000	41.504005 E 9.399481 S

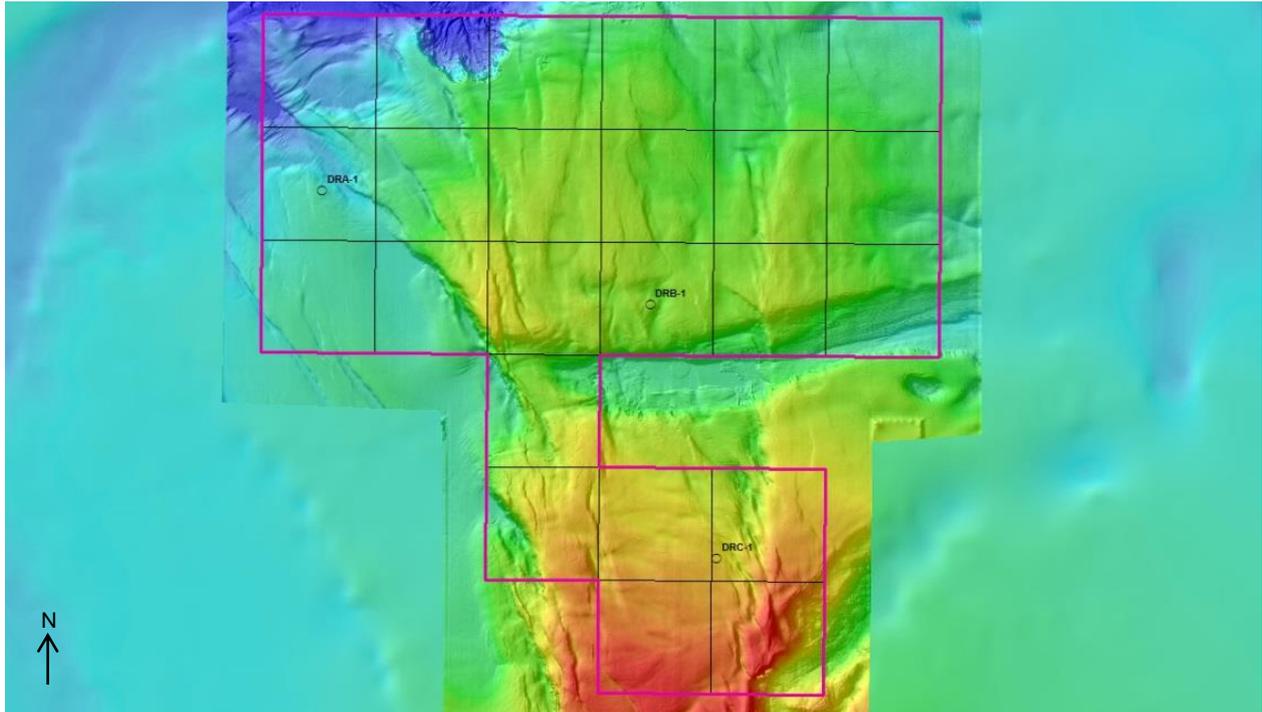




**Legend**

- ⊛ Wells (Gas)
- Wells (Planned)
- Prospects
- Fields (Gas)

Figure 3-3 Location of existing and future wells in Block 2. The upper map shows the entire Block 2 area. The lower map shows the Western Area and Sea Gap. (Source: Statoil)



### Legend

- ⊗ Wells (Gas)
- Wells (Planned)
- Prospects
- Fields (Gas)

Figure 3-4 Location of existing and planned future wells in Block 2. The map shows Davie Ridge (Source: Statoil).

### 3.3.2 Design of project

The design of the project includes:

- > Planning of well design and drilling methods (cf. chapter 3.5.1 and 3.5.2);
- > Planning of types and composition of drilling fluids to be used (cf. chapter 3.5.3);
- > Preparation of cementing planning programme (cf. chapter 3.5.3);
- > Planning of support and logistics (cf. chapter 3.5.6) and
- > Elaboration of environmental and social management plans (Cf. chapter 9).

### 3.3.3 Drill ship

The drilling of the exploration wells is planned to be carried out from the drill ship *Discoverer Americas* from Transocean (Figure 3-5). Later on in the drilling campaign this drill ship might be replaced with a similar drilling facility. The drill stem tests can potentially be done utilizing another drill ship/rig.

A drill ship is an oceangoing vessel with a drilling platform and drilling derrick in the middle and the usual drilling equipment such as rotary table, top drive, drawworks, mud pumps, pipe handling system, solids controls, blowout preventer (BOP) stack, well control systems and equipment.

#### Use and functioning of drill ships

Drill ships are typically employed in deep and ultra-deep-waters ranging from 600 to 3000 meters. During drilling, the drill string extends down to the ocean floor through the so-called moon hole. Drill ships use dynamic positioning equipment to keep precisely aligned with the drill site, using satellite information and sensors on the subsea drilling template to keep track of the drilling location. Using this data, computer controlled thrusters on the underside of the hull constantly move the ship to keep it lined up with the well.

Drill ships are also provided with:

- › Storage facilities for fuel oil, drilling mud, drill water, bulk mud, bulk cement, sack material, potable water
- › Cranes for materials handling;
- › Flare boom attachment positions for well test flaring operations;
- › Electrical power generation system;
- › A helipad to receive supplies and transport staff and
- › Accommodation for staff



*Figure 3-5 The drill ship Discoverer Americas that will be drilling further wells in Block 2. (Source: Transocean)*

Table 3-2 Selected features of the drill ship Discoverer Americas.

<b>General characteristics</b>	
Rig Type	6th Generation Ultra-deepwater
Design	Transocean Offshore Enhanced Enterprise class, double hull, dual drilling activity.
Builder	Daewoo Shipbuilding & Marine Engineering, Okpo, South Korea
Year Built	2009
Classification	DNV Drill Class 1A1, ship-shaped drilling unit, EO DYNPOS, AUTR, DRIL, HELDK, CRANE, TEMPSTORE
Flag	Marshall Islands
Accommodation	200 berths
Helideck	Sized for Chinook 234 helicopter
Moonpool	72 1/2 ft. x 30 ft
Station Keeping	Dynamically Positioned
Max Drill Depth	40,000 ft / 12,191 m
Max Water Depth	12,000 ft / 3,657 m
Operating Conditions	Wind 60 knots, Wave 30 ft
Storm Conditions	Wind 100 knots, Wave 50 ft
Technical dimensions	Length 255 m, Breadth 38 m, Depth 19 m, Operating Draft 13 m, Ocean Transit Draft 0 m, VDL - Operating 20,000 mt
<b>Capacities</b>	
Liquid Mud	2,447 m <sup>3</sup>
Drill Water	3,179 m <sup>3</sup>
Potable Water	794 m <sup>3</sup>
Fuel Oil	5,723 m <sup>3</sup>
Bulk Mud	453 m <sup>3</sup>
Bulk Cement	453 m <sup>3</sup>
Sack Material	16,000 sacks of 50 lbs (16,000 sacks of 23 kg)

### 3.4 Mobilization phase

Prior to drilling, clear formalities for all vessels will be done from Mtwara Port.

#### 3.4.1 Delivery of good and supplies

The mobilization phase begins with delivery of goods and supplies (chemicals, drill casings, provisions etc.) to the Mtwara Port (Statoil’s onshore operation base cf. 3.5.6) and then to the drill ship at the drilling location.

#### 3.4.2 Survey of seabed

When *Discoverer Americas* arrives at the location and is in position, a seabed survey is carried out using a Remotely Operated Vehicle (ROV) to obtain images of the seabed and confirm that there are no obstacles or structures around the well location that may affect drilling operations (Figure 3-6). The ROV will also be used to place beacons around the well centre as aids for the drill ships position keeping. There will be 8 -10 beacons, at a distance of 50-100 m from the well centre. All beacons will be retrieved after operation.

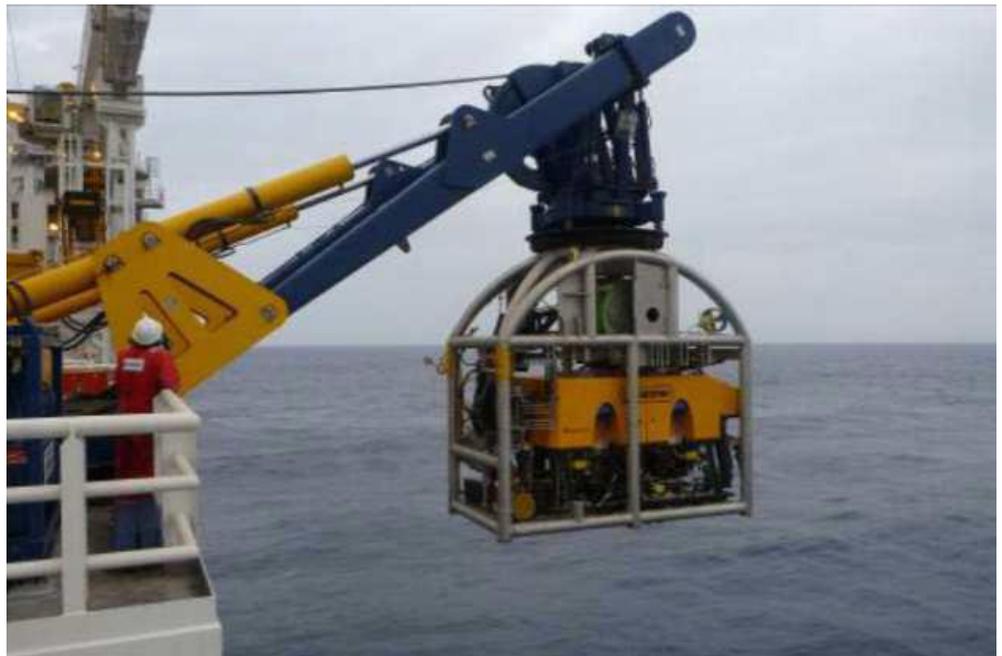


Figure 3-6 Remotely Operated Vehicle being launched (Source: SERPENT project)

#### 3.4.3 Establishment of safety zones

Safety zones will be established around the drill ship, where no vessels other than those involved with the rig/drill ship are allowed to enter. Because of the risk of piracy in Tanzanian waters, this zone will be larger than what is used in most other parts of the world, and as a security measure Statoil will monitor movements in an area around the drilling vessel.

The following safety zones will be established:

- › **Surveillance Zone** situated outside 15 nautical miles (27.8 km); this area will be continuously monitored and all targets will be classified and identified within this zone;
- › **Warning Zone** situated within a radius of 10-15 nautical miles (18.5-27.8 km) from the drill ship; if a target moves into the warning zone, it will be watched closely for changes in course and speed towards the drilling vessel;
- › **Interception Zone** situated within a radius of 2-10 nautical miles (3.7-18.5 km) from the drill ship; all vessels in this zone will have been classified and identified. If a vessel is classified as a threat, the security vessel implements security measures in accordance with its Rules of Engagement to ensure the protection of all personnel and all contracted vessels and
- › **Exclusion Zone.** This zone extends from the drill ship out to 2 nautical miles. Fishing boats or other similar vessels that are not classified as a threat will be escorted out of the area by the security vessel.

## 3.5 Operation (Well-drilling) phase

### 3.5.1 Drilling procedure

Drill

Once in position at the designated well-site, drilling will commence. The drill used for the drilling operation consists of a drill string that is provided with a drill bit in the end. The drill string consists of multiple drill pipes screwed together. The rotary table on the drill ship rotates the drill string and the drill bit, which grinds through the underground chipping off pieces of rock, called cuttings.

Drilling mud and cuttings

As the drilling hole descends deeper into the ground, a constant flow of drilling mud is pumped down to the drill bit through the centre of the drill string and returned to the surface (Figure 3-7). This thick, viscous fluid consists of bentonite clay, a fluid (water or synthetic oil), barite and a mixture of special chemicals. The drilling mud removes and transports the cuttings to the surface, lubricates and cools the drill bit, seals the wall of the well and controls pressure inside the well.

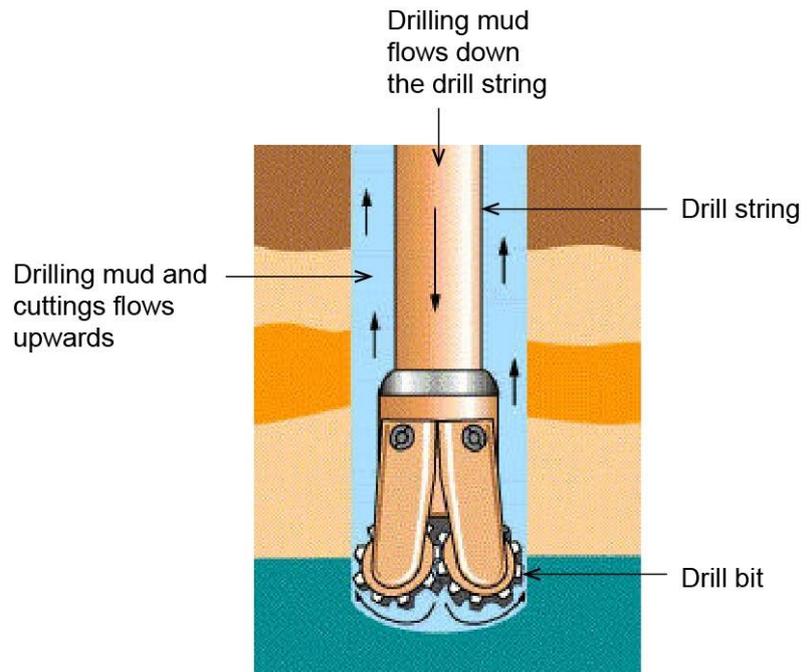


Figure 3-7 Schematic illustration of circulation of drilling mud and cuttings in the drill bit (Source: COWI)

After completion of the upper sections of the well the Blow Out Preventer (BOP) (Cf. section 3.5.4.) and a so-called drilling riser is installed. The BOP is installed on top of the well head structure. The riser provides a closed connection between the BOP and the drill ship (Figure 3-8).

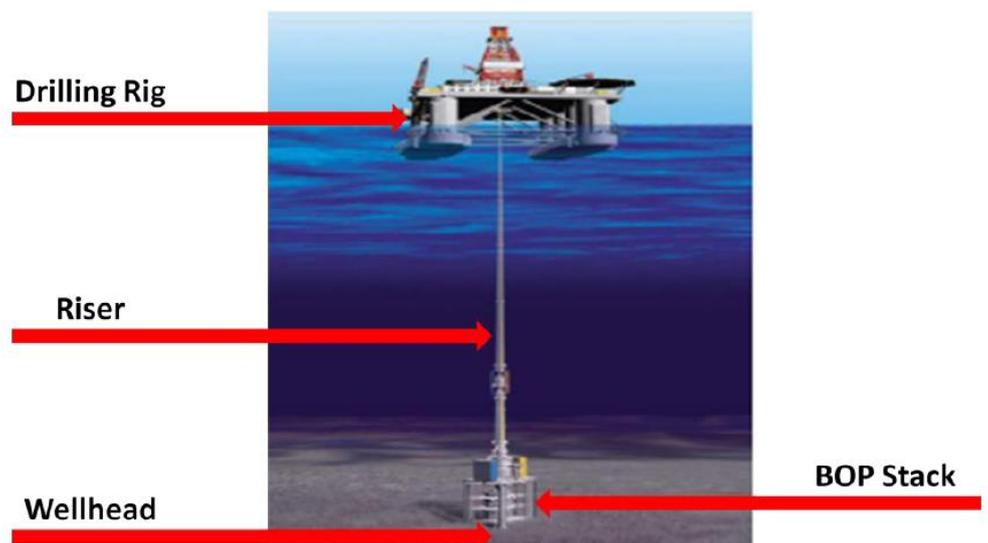


Figure 3-8. Schematic view (not to scale) of a riser on a semi-submersible rig, similar to that used on a drill ship (Source: COWI)

The upper hole sections of each well typically extending some 400-600 m below the seabed (length depending on depths of potential hydro carbon bearing reservoirs) will be drilled without a riser in place. During this phase drill cuttings and muds will be discharged directly on the seabed in proximity to the well according to standard practice in the industry. These sections are drilled with

seawater and sweeps and/or water based drilling mud (WBM). The top hole (first section) can also be jetted in place using seawater.

The lower sections of the well will be drilled with low toxic synthetic oil based mud (SOBM). Cuttings and SOBM are circulated to the drill ship where cuttings are removed from the drilling mud and cleaned to allow for max. 6.9% oil on cuttings (expected performance is 3-4%) before discharged to the sea. Separation of cuttings, drilling mud, base oil and other drilling mud components takes place in the solids control system.

Solids Control system A solid control system consists of:

- › A primary system of shale shakers that are vibratory screens;
- › A secondary system (the cuttings drying system) consisting of a cuttings dryer and a decanting centrifuge system;

The solids control system onboard the *Discoverer Americas* includes and functions as follows:

- › The **primary solids control system** comprises of five shale shakers with high gravity vibrators to remove drilled cuttings from the drilling fluid system. The drilling fluid is recycled and the wet solids is treated in the cuttings dryer system for further removal of oil and drilling fluid;
- › The **cuttings dryer system** consists of two M-10 mud recovery centrifuge dryers that rotate at high speed to produce dry, powdery damp cuttings.

The spent mud is added drilling chemicals and pumped into the well again and reused as much as technically possible. The cuttings will have some mud components adhered including some of the base oil included in the drilling mud.

Occasionally the recalculated mud must be transported to the Mtwara Port Mud Plant (Cf. 3.5.6) for reconditioning before it can be used again.

Cleaning capability of *Discoverer Americas* Solids Control System

There is no specific national requirement regarding content of oil on cuttings in Tanzania. Most mobile drilling installations operating internationally have cuttings cleaning equipment that is guaranteed to give <6.9%, which is the discharge limit in most parts of the world. This also applies to the *Discoverer Americas*. However, the operations indicates that a content of oil on cuttings between 3-4% can be expected using the existing treatment system onboard.

Based on this, cuttings will be discharged to sea if the oil content is lower than 6.9%. If oil content is higher than 6.9 % it will be transported to shore in skips, dried at the waste management site and transported to a cement factory for use in the production of cement. Currently there is an agreement with Tanzania Portland Cement Company Cement factory in Dar es Salaam.

Options for handling of cuttings

The following options apply for handling cuttings from the lower well sections that are drilled with SOBM:

- › Using the existing treatment plant on the *Discoverer Americas* (or other similar drill ship that may be employed in the future) and discharge to sea if oil content is <6.9% (expected 3-5% based on recent wells drilled with this drill ship and similar to what has been achieved during the drilling of the finalized wells in Block 2, recent operations indicate 3-3.5%);
- › Shipping of cuttings from the lower sections (when riser in place) to shore, for onshore treatment in a TCC plant and recycling in a cement factory;
- › Shipping of cuttings from the lower sections to shore, for laying out to dry and recycling in a cement factory;
- › Installation of a TCC-unit onboard the drill ship

These options are discussed in chapter 8.2.5.

#### Cementing

As the well is drilled, a metal casing is placed and cemented into place inside the well to line it and stabilize the hole to prevent it caving in. The casing also isolates aquifers and hydrocarbon bearing zones through which the well passes, thus preventing liquids or gases entering the well prematurely. After casing strings have been installed for each section they are cemented in place.

The drilling of each well is expected to take between two to four months, typically 90 days.

#### Pilot hole

For some wells, a pilot hole may be needed before drilling the top hole section, in order to assure high quality log data from the shallow section, and to reveal presence of pockets of gas or water under pressure. Such pilot holes are drilled with a small hole diameter i.e. 12 ¼” using seawater and sweeps or Water Based Mud (WBM). The pilot holes may either be drilled immediately upfront of the main borehole, or at an earlier stage, allowing for optimizing on planning time and rig schedule. Such pilot holes will be filled with mud or cement before abandonment.

### 3.5.2 Well design

The preliminary design in terms of hole sections and casings of the next well planned to be drilled (Mronge-1) is shown in Figure 3-9 and in Table 3-3.

The planned well design is a well-recognised and proven design. The Target Depth (TD) is 3500 m below sea bed which is considered as a deep well. Contingency strings will be in place to still achieve overall well objectives even in a contingency situation. The wells will be drilled and constructed using materials of high international standards. The potential for shallow hazards/gas are identified, but by well design, drilling procedures and selection of the location the risks are reduced to a minimum.

A total of 830 m<sup>3</sup> of cuttings is estimated to be generated and discharged for the Mronge-1 (550 m<sup>3</sup> from the upper sections that will be discharged directly on the

seabed and 280 m<sup>3</sup> from the lower sections that will be brought onto the drill ship cleaned and discharged).

Future wells may generate other cuttings volumes depending on their depths (TD). The estimated total amount of cuttings generated in some previous wells were

- › 336 m<sup>3</sup> at Zafarani-1,
- › 331 m<sup>3</sup> at Lavani-1
- › 166 m<sup>3</sup> at Tangawizi

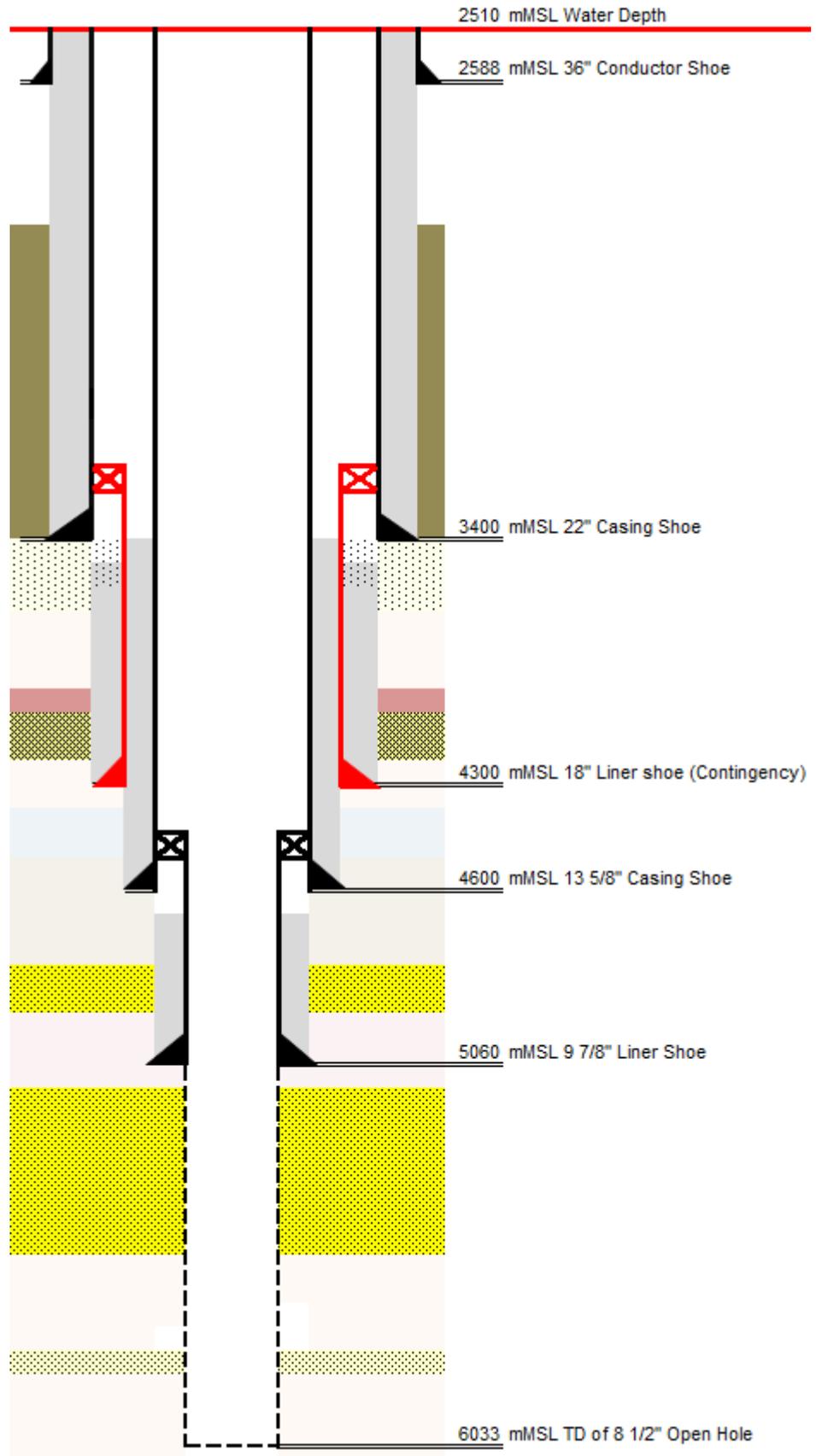


Figure 3-9 Schematic outline of the Mronge-1 exploration well (with contingency string).  
(Source: Statoil)

Table 3-3 *Planned design for the proposed deep-water exploratory well at Mronge-1. Amounts of cuttings generated in each section and the types of drilling fluid that will be used for the drilling of each section is shown*

Section/ Hole Size	Depth range (m)	Amount of cuttings generated (m <sup>3</sup> )	Amount of cuttings generated (tonnes)*	Drilling fluid used
36" and 26"	2,538-3,400	550	1320	Sea water and sweeps and Displacement WBM
17.5"	3,400-4,750	200	480	SOBM ENVIROMUL
12.25"	4,750-5710	70	168	SOBM ENVIROMUL
8.5"	5710-6060	10	24	SOBM ENVIROMUL
Total		830	1992	

\*Based on a density of cuttings of 2.4

### 3.5.3 Materials that will be used during the drilling operations

The following main categories of materials will be used during the drilling:

- › Drill pipes and drill casings;
- › Drilling materials including:
  - › Drilling fluids (Sea water and sweeps, Water based Mud (WBM) and Synthetic Oil Based Mud (SOBM) to control well bore pressure, lubricate the drill bit and bring cuttings to the surface. Mixing the WBM at the Mud Plant at Mtwara Port or at the drill ship will require a certain volume of freshwater per day;
  - › Cementing chemicals;
  - › Rig chemicals;
- › Diesel fuel for the drill ship, supply vessels, security vessels
- › Helifuel for helicopter and
- › Drinking water and food for the crew.

For the Mronge well, the estimated quantities of these materials will be as stated in the sections below. For the other wells the quantities will be similar, but will depend on the depth of the well, the final well design that is not currently decided and the duration of the drilling. This well specific information can be provided to NEMC prior to any drilling if decided.

### Drill pipes, drill casings and drilling chemicals

Drill pipes, steel casings and drilling chemicals will be imported into Tanzania from well-established global suppliers. Mtwara Base will receive and store these materials before they are transported to the drill ship. Some chemicals and equipment will be left onboard from the Mozambique operation and arrive with the ship when it enters Tanzania.

Mronge will be drilled with the following casing sizes:

- › Well head. DrilQuip Big bore II
  - › 36" = 75m Conductor
  - › 22" = 815m
  - › 13 3/8" = 1200m
  - › 9 7/8" = 460m
- › In addition contingency string will be ordered for the following sizes:
  - › 18" = 1000m and 11 3/4" = 300m.

For each sizes there will be an additional 10% back up. In addition the following casing accessories will be used: liner hanger, casing hanger, cement shoe and centralizers.

### Drilling fluids

Table 3-4 show the composition of the seawater and sweeps, Water Based Mud (WBM) and the synthetic oil-based mud (SOBM) that is planned to be used at Mronge-1. Similar drilling fluids will be used for the other wells planned at Block 2. In case other fluids will be used that have different environmental characteristics, NEMC will be notified well in advance.

#### Klif classification

The components of the sweeps and drilling muds have been classified in terms of their ecological hazard based on toxicity, biodegradability and bioaccumulation characteristics using the rating employed by the Norwegian Climate and Pollution Agency (Klif) for offshore chemicals. This rating system is based on OSPAR Recommendation 2010/3 on a Harmonised Offshore Chemical Notification Format (HOCNF) for chemicals used in the offshore oil and gas industry in Europe. The hazard for each component is expressed using colour codes as follows:

- › Black chemicals: Chemicals which basically cannot be discharged. Permits are given in special cases;
- › Red chemicals: Chemicals which pose an environmental hazard and should therefore be replaced. Permits are given on condition that special priority is given to identifying substitutes for these substances;

- › Yellow chemicals: Chemicals in use but not included in any of the other categories. Normally permitted without specific conditions and
- › Green chemicals: Chemicals on the list from the OSPAR PLONOR list (i.e. chemicals that are considered to Pose Little or No Risk to the Environment). These chemicals are permitted without specific conditions.

From Table 3-4 it appears that all chemicals to be used are either green or yellow.

The upper sections of the well are planned to be drilled with seawater and sweeps and WBM.

Seawater and sweeps	Seawater and sweeps is basically bentonite diluted with seawater and treated with chemicals to the correct properties in terms of pH, alkalinity and viscosity.
WBM	WBM consists of barite and bentonite (83 % and 13 % of the total weight, respectively) mixed with freshwater and added chemicals for adjusting the alkalinity and viscosity.
	No components used in the sea water and sweeps and the WBM are toxic.
SOBM	<p>The SOBM (ENVIRONMUL) that is planned to be used for the Mronge-1 drilling is mainly composed of the low toxic ESCAID 110 base oil (64 % of total weight) and barite (21 % of total weight). Other, but similar base oils may be used for drilling the other wells.</p> <p>The SOBM will be recirculated and only a small fraction of the SOBM components will be discharged to sea (adhered to the treated cuttings) (Cf. Table 3-4).</p> <p>The methods used to separate drilling mud components from the cuttings are described in Chapter 3.5.1 and Chapter 3.5.7.1</p>



*Figure 3-10 Mtwara Port. Container being loaded onto supply vessel in the foreground. Mud plant and storage in the background. (Source: COWI).*

***Water for preparation of drilling mud***

Fresh water is needed for the preparation of water based mud. For the Mronge well the WBM has to be mixed onboard the drill ship, as there is no capacity available currently at the Mud Plant in Mtwara. . The need for water is estimated to be in the range of 100 m<sup>3</sup> per day. However, a water maker with a capacity of 150 m<sup>3</sup> has been purchased for installation onboard the ship. This system is expected to be installed during the third to fourth quarter of 2013. Meanwhile, drillwater will be transported from Mtwara to the drill ship.

For the mixing of SOBMs at the Mud Plant in Mtwara, only minor water volumes will be used.

Table 3-4. Composition of drilling mud planned to be used for the Mronge-1 exploration drilling. Total usage and discharges of the different drilling mud components are indicated. Klif ratings are also indicated...

Product name	Function	Total usage (Tonnes)	Total Discharged (Tonnes)	Klif Environmental classification
<b>Sweeps chemicals</b>				
Bentonite	Viscosifier	137	137	Green
Soda ash	pH control	1	1	Green
Caustic soda	Alkalinity	1	1	Green
BARAZAN D	Viscosifier	7	7	Yellow
<b>WBM chemicals</b>				
Bentonite	Viscosifier	19	19	Green
Barite	Weighting material	129	129	Green
Caustic soda	Alkalinity	0.3	0.3	Green
PAC RE	Viscosifier	1.6	1.6	Yellow
DEXTRID E	Viscosifier	1.6	1.6	Yellow
<b>SOBM ENVIROMUL chemicals</b>				
ESCAID 110	Base oil	190	14	Yellow
Barite	Weighting material	62	10	Green
BARACARB 50	Lost circulation	4.5	1	Green
BARACARB 150	Lost circulation	4.5	1	Green
CaCl <sub>2</sub>	Salt inhibitor	13	3	Green
GELTONE II	Viscosifier	11	2	Yellow
EZ MUL NT	Emulsifier	7	1	Yellow
Lime	Alkalinity	4.5	0.1	Green
<b>Riser Clean Up chemicals</b>				
BARAZAN D	Viscosifier	0.25	0.25	Yellow
BARACLEAN GOLD	Surfactant	4	4	Yellow
Barite	Weighting material	6	6	Green

***Cementing chemicals***

Cement is required in drilling operations to fix the casings in the hole and prevent upward migration of hydrocarbons from around the outside of the well casing. Cement is pumped into the well and up around the casing and typically sets in five to six hours. Materials used for the cementing operations include cement and a variety of chemical additives such as defoaming agents, foaming agents, dispersants, accelerators, strength retrogressors, retarders, anti-settling agents, fluid loss agents, spacers, fluid loss control additives and gas control agent. Table 3-5 show the amounts of different cementing chemicals that is planned to be used for the drilling of Mronge-1.

Empty chemical containers and bottles with remnants are cleaned at the waste yard wash plate and then compressed in a compactor. Recyclable materials are sorted and recycled including: plastic bottles, aluminium cans, drums, glass, wood and scrap metals. Plastic is currently sorted and compressed into bails that are transported to a factory in Dar es Salaam. Aluminium cans and drums are compressed and transported to a licensed smelter in Dar es Salaam. Glass is crushed and is used by other contractors for example road construction Chemical remnants are burn in the incinerator.

*Table 3-5. Cementing chemicals planned to be used for Mronge-1.*

<b>Material Description</b>	<b>Function</b>	<b>Amounts</b>
Dyckerhoff G	Cement	900 MT
Dyckerhoff G + 35% SSA-1	HT cement	200 MT
EZFLO II	Cement Flow enhancer	2000 lbs
D-Air 3000L	Defoamer	700 gals
Microbond HT	Expansion additive	12,000 lbs
Calcium chloride	Accelerator	5000 lbs
MicroMatrix	Microfine Cement	165,000 lbs
HGS 6000	Light weight additive	189,000 lbs
Microblock	Anti-gas migration	4500 gals
Flostop 5000L	Gellation additive	700 gals
CFR-3L	Friction Reducer	500 gals
Gasstop exp	Fluid loss additive	4000 gals
Gascon 469	Stabilizer/Anti-Gas	1100 gals
SCR-100L	Retarder	1200 gals
HR-25L	HT Retarder	200 gals
Halad 413L	HT Fluid Loss Additive	900 gals

Flourosce Dye	Dye	100 lbs
Tuned Spacer III	Soacer Blend	60,000 lbs
Pen-5M	Spacer Surfactant	660 lbs
Musol A	Spacer Surfactant	1,320 gals
Sem-8	Spacer Surfactant	700 gals
Hyflo IV M	Spacer Surfactant	170 gals
<b>Contingency</b>		
Econolite/Injectrol A	Light weight Additive	660 gals
WellLife 734 fibers	Fibers-Loss circulation	2,000lbs

Only a small amount of these chemicals will be discharged to sea. The chemicals will be evaluated in terms of Health, Safety and Environment (HSE) classification by Statoil's Chemical Centre before use. This involves QA for the documentation, total HSE evaluation, product substitution and mitigation actions. Chemicals will be supplied by Haliburton who are responsible for securing a certificate of registration from the relevant authority (Cf. Table 11 section 4.1).

#### *Rig chemicals*

A variety of rig chemicals will also be used onboard the drill ship in connection with the drilling operation.

Monthly averages use of rig chemicals for Discoverer Americas are:

- › Diesel Fuel- 1547 m<sup>3</sup>
- › BOP Stack Magic 200F- 9431.1 Ltrs
- › Cleaning/ Rigwash- 1892 Ltrs
- › Dope- 151 kg
- › Detergent- 175 kg

All such chemicals will have MSDS data sheet and Health, Safety and Environment (HSE) classification.

Chemicals are stored separately in tightly sealed containers/drums, which are labeled clearly with the type of hazard. Wastes are then collected by the Waste Management Contractor, checked, and transported to final disposal. The empty chemical containers and bottles are dealt with as described for cementing chemicals above.

Some of the chemicals and certain lubricants have the potential to cause damage to humans or the environment, and are considered hazardous. All chemicals will be

handled, stored and used in strict accordance with laws and regulations of Tanzania and Statoil requirements/guidelines.

#### Oter Materials

The following fuel consumption is expected:

- › The diesel consumption of the drill ship is estimated to 30-60 m<sup>3</sup> per day with an average of 33 m<sup>3</sup> per day
- › Each of the two supply vessels is expected to consume 10-15 m<sup>3</sup> diesel fuel per day when sailing and 5-10 m<sup>3</sup> when standby at sea.
- › Each of the two helicopters serving the rig will consume 900 l aviation fuel per flight, with an average of 10 flights a week; the weekly consumption is estimated at about 9000 l The Helicopter › Heli fuel: In average 10 flights per week, 900 l per flight.

Drinking water will be supplied in bottles.

### 3.5.4 Blowout prevention

One of the greatest potential environmental concerns during exploration well drilling is the uncontrolled release of hydrocarbons (gas or oil). Clearly, it is also the greatest safety concern and consequently, well control is fundamental to this drilling process.

Normally, the weight of the drilling fluid in the well bore is calculated as to counteract the natural well pressure. If the natural formation pressure is higher than forecasted in the well design, formation fluids may be released into the wellbore in an uncontrolled fashion causing pressure imbalance inside the well and which, if not controlled, it might result in a large proportion blow-out.

BOP

The Blowout Preventer (BOP) and all well control equipment is thoroughly inspected prior to installation and subsequently pressure tested on a routine basis. The BOP provides a mechanical means of shutting the well in the event of drilling into over pressured zones. This equipment is installed on top of the well head at the seabed and ensures the well integrity and pressure control during the drilling operations.

### 3.5.5 Occupational Health and Safety

Occupational health and safety issues are relevant to those aboard the drill ship and supply vessels, helicopter crew and staff and workers at the Mud Plant and Mtwara Port.

HSE Policy

Statoil has a comprehensive Health Safety and Environment (HSE) Policy which is implemented on all their operations and service providers. Statoil's general aim is zero harm to people and the environment and has developed relevant standards for achieving this.

In addition the drill ship and supporting vessels will operate to internationally recognized standards, including those of health and safety at sea to minimise risk to personnel, equipment and the environment.

#### Chemical management

Chemicals involved in operating the ship and its activities are under chemical management.

Products and chemicals not directly used for the drilling operation but necessary for the running of the ship, such as engine oils and chemicals for maintenance are handled by the rig owner. However, all such chemicals will be assessed and approved by Statoil prior to operations.

The chemical substances used for the drilling operation is defined as those used for drilling and cementing, dope for drill pipe and casing, BOP-fluids and rig wash. These five product groups are used in areas where discharge will or may occur, and Statoil will do hazard and risk assessment for each product involved. All relevant products will be assessed.

Some of the chemicals and certain lubricants have the potential to cause damage to humans or the environment and are considered hazardous. All hazardous chemicals are to be accompanied by their corresponding Material Safety Data Sheets (MSDS). All chemicals will be handled, stored and used in strict accordance with laws and regulations of Tanzania and Statoil requirements/guidelines. The MSDS of each product and relevant hazardous materials/waste will be considered according to in the Waste Management Plan.

Drilling also requires the handling and storage of some radioactive sources that will be stored on the drill ship as per standards for safe containment and exposure and carefully sited to ensure safety of workers. Similarly, small amounts of explosives will be available and stored either aboard the drill ship or in Mtwara Port.

### 3.5.6 Supply, Support Logistics

#### Supply Vessels

The drill ship will be supported by two supply vessels, the *Far Spica* and the *Far Scotsman* (Figure 3-11, Table 3-6). These vessels will transport materials and supplies that are required during drilling operations from Mtwara Supply Base, located in Mtwara Port. The vessels will also assist with emergency responses, including combat of potential spills of hydrocarbons. (Cf. description in chapter 8.2.1)



Figure 3-11. The supply vessel FarScotsman, which will be employed during the drilling operations.(Source: Farstad shipping).

Mtwara Port

During the well drilling phase the supply vessels will sail between the drill ship and Mtwara port once or twice a day, covering a distance of about 100 km each way. Marine operations will comply with MARPOL and other applicable international, regional and national maritime legislation.

Table 3-6 Selected features of the Supply Vessel Far Scotsman and Far Spica

General characteristics	
Length Overall	81.7 m
Maximum Draft	6.5 m
Gross Tonnage	3527 mt
Complement	30 persons
Main engines	9996BHP
Year Built	Far Scotsman 2012; Far Spica 2013
Capacities	
Fuel Oil	917 m <sup>3</sup>
Potable water	730 m <sup>3</sup>
Drill water	1915 m <sup>3</sup>
Mud	1270 m <sup>3</sup>
Dry Bulk storage	251 m <sup>3</sup>
Methanol	100 m <sup>3</sup>
Brine	1270 m <sup>3</sup>

Base Oil	319 m <sup>3</sup>
Slop	163 m <sup>3</sup>
Rig slop (Dirty methanol)	163 m <sup>3</sup>
Oil recover	1143 m <sup>3</sup>

#### Services and facilities Mtwara Port

Mtwara Port will provide the following services and facilities:

- › Lay-down area for pipes and equipment;
- › Mud Plant for processing and storage of drilling fluids and dry bulk chemicals;
- › Water supply;
- › Customs clearance;
- › Covered storage areas for bulk goods;
- › Wash down area for equipment and machines;
- › Stevedoring services;
- › Communication and emergency services to 2nd line in Dar es Salaam and
- › A small base service office manned by two persons. Statoil's Main office is in Dar es Salaam.

These services will be conducted according to International Standards as specified in Contract Terms and Conditions and according to Statoil Guidelines for Supply Chains Management.

The Mtwara Port facility is presently used by Statoil and other Operators such as Ophir-BG and Petrobras under the Multi User Facility Agreement (MUFA) which is being operated by BG on behalf and in close cooperation with other MUFA partners. BG holds the responsibility for licences needed for the operations at the base and are also the owner of the landlease agreement with TPA as landowner.

Supply Base Services (SBS) is the company contracted by Statoil for providing the logistic service at the base. A new company (ASCO) will take over as the base logistic provider from end of October 2013. This service does not include waste management. Statoil has a company representative at the base to overlook the activities, follow up the contractor and coordinate with MUFA.



Drill casings and fuels storage at Mtwara



Supply containers



Loading dry goods on supply vessel from truck



Cargo deck on supply vessel

Figure 3-12. Services and facilities at Mtwara Port for offshore drilling operation. (Source: COWI).

## Waste Management

Waste Management is currently taken care of by SBS at the Mdenga Waste Management site in Mtwara. However, waste is received and partly stored at the base before transported to the Mdenga site.

Supply Base Solutions Ltd (SBS) Waste Management Facility is sited on a 26 acre plot, located in Mdenga, which has been dedicated for industrial use, as per the Municipal Master Plan. SBS undertook an EIA study in 2011 and the Waste Incineration Project was issued with an Environmental Impact Assessment Certificate, registration No. EC/EIS/440 29th August 2011 by NEMC.

The facility has been operational since 2011 and has now developed into one of the leading facilities in Tanzania for waste management practices.

SBS are managing all waste streams returned onshore from the Tanzanian offshore drilling campaigns, the Port of Mtwara and certain Mtwara camp facilities.

SBS's goal is to reduce, reuse and recycle waste streams, with a commitment to educate the Tanzanian National workforce and recycle all recyclable waste streams in Tanzania through cooperation from all Stakeholders. The Waste Management Facility currently employs 65 Tanzanian Nationals from Mdenga Village.

Equipment and plant on site for phase 1 of the Facility:

- › 2x industrial type incinerators. Capable of safely disposing over 3,000kgs/day of none recyclable material.
- › Concrete floored area 2,500m<sup>2</sup>; including 450m<sup>2</sup> roofed area.
- › Over 2,500,000 Ltr of above ground fluid storage capability (bunded), with an additional 300,000lt ISO tank storage.
- › Nature Group CTU1G, a specialist, containerised treatment unit for drill fluids and oil contaminated liquids. Treatment capacity - up to 60m<sup>3</sup>/day
- › Modern recycling equipment, including drum crusher, glass crusher, baling machines, fluorescent tube crusher, aerosol piercer, all aimed at increasing the amount of waste that can be recycled.
- › Other plant including, generators, forklifts and cranes.

To date the following waste has been recycled or reused.

- › 150,000 Ltr of waste oil.
- › 1,600,000 Ltr of slops/sludge treated.
- › Over 700tons of drill cuttings.
- › 30tons of scrap metal, including 700 metal drum and 200,000 soda cans.
- › Over 20tons of waste plastics, including 450m<sup>3</sup> of plastic bottles, recycled.
- › 500 wooden pallets repaired and reused.

#### Helicopter transport

Personnel will be transferred to the drill ship by helicopter from Dar es Salaam Airport. Mtwara Airport will serve as a reserve service option for mobilization of personnel, medevac and small bulk equipment to and from the drilling ship.

Up to ten helicopter trips per week from Dar es Salaam will be made to supply personnel and small goods directly to the drill ship. The distance between Dar es Salaam and the well site is about 250 km. Mtwara Airport may serve as a back-up for emergencies or contingency operations.

A new contractor has been chosen from 1<sup>st</sup> January 2014. This service will include two helicopters for transport of people and one dedicated SAR (Search and Rescue)

helicopter stand by in Dar. This SAR-helicopter will also be equipped to detect any spills of oil during darkness.

### 3.5.7 Waste generation, discharges and emissions to air

#### 3.5.7.1 WASTE GENERATION AND DISCHARGES

The main sources of waste from the drill ship include:

- › Drill cuttings;
- › Sludge and slop water;
- › Other wastes from drill ship activities

##### *Drill cuttings*

Drill cuttings from the upper section(s) of the borehole drilled with sea water and sweeps and/or WBM (before the riser is connected) will be discharged to the sea bed according to standard practice. Cuttings from these upper section(s) of the borehole will not contain any oil based fluids. Drill cuttings from the lower sections of the borehole will be transported through the riser up to the drill ship where they are treated and discharged or transported to Mtwara for treatment and disposal if not treatment onboard the ship is possible. For the two upper sections that will be drilled before the riser is installed, the cuttings including the drill fluid will be discharged to sea as it is not technical possible to transport these up to the drill ship for treatment. For the sections drilled after the riser is installed, the cuttings will be transported up to the drill ship and treated in the Solid Control System onboard. This includes the shaker and the cuttings cleaner. A part of the SOBMs will remain on the cuttings that will be discharged to sea after treatment. Based on the recent drilling operations it is expected to be significantly below 6.9 % which is what the treatment system onboard the drill ship is designed and guaranteed for. Expected value is 3-4 %. The SOBMs that is removed from the cuttings will be reused. If for any reasons, the SOBMs-content on the cuttings should be above 6.9 %, the cuttings will be transported to shore to Mtwara to be dried – before being transported to Dar for use in the cement production according to agreement with a cement factory. However, transport of cuttings in trucks over such a long distance should be limited as far as possible as it introduces many significant environmental and health/safety risks and impacts.

Regarding the actual method used for treatment of the drill cuttings, Statoil is in the short term planning to use the existing SCS-system onboard the drill ship to clean the cuttings when drilling with SOBMs and to discharge the treated cuttings to sea as an environmental risk assessment has shown that this is not expected to have any significant impact on marine life in these environments. However, as many future wells might be drilled as a part of the development phase (production wells), and the further exploration/appraisal wells, Statoil will evaluate the possibility to have a Thermal-mechanical Cuttings Cleaner (TCC-unit) installed in Mtwara or at the rig/drill ship.

### *Sludge and slop water.*

Sludge refers to the residual, semi-solid material left from industrial wastewater or sewage treatment processes. It is a heavier liquids that contain high quantities of fine solids, spent oil based mud or other drilling fluids. Slop water is the water collected from the various drains from dirty deck areas onboard a rig. This is a mixture of rain water, water containing oil or water-based drilling mud from the drains at the drill floor, soap and dope from cleaning of pipe threads at deck, mud and chemical residuals from the mud pump room and mud mix room, or even water mixed with -hydraulic oil from any leakage. Most of the slop will be treated in the Slop Treatment Unit onboard *Discoverer Americas*. The remaining slop that is not treated onboard and the sludge will be transported to onshore for treatment and disposal. Slop treatment is described in section 8.2.4;

### *Other wastes from drill ship activities*

Waste from drill ship activities are collected, some of it grinded or compacted and transported onshore. These wastes include:

- › Maintenance by-products (lube oil and other greases);
- › Packaging waste (paper, card, drinking bottles, soft drink cans, wood, sacks, drums and grease/paint cans),
- › Scrap metal and empty chemical containers/drums
- › Kitchen waste. The food waste will be grinded onboard and discharged and
- › Sanitary waste and grey water that is treated onboard the drill ship

Details on amounts of waste generated during the drilling operations and the waste management as well as assessment of environmental impacts of waste is presented in chapter 7.2.4.4.

### 3.5.7.2. AIR EMISSIONS

During drilling exhaust from engines and power generators on drill-ship, supply vessels, support vessels and helicopters will be emitted to the air and from burning gas during the testing of wells (DST). Emissions will primarily be carbon dioxide (CO<sub>2</sub>), but also small quantities of nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), hydrocarbons, and particulate matter. Levels and impacts of air emissions are presented and discussed in section 7.2.3.5.

### 3.5.8 Drill stem testing

A Drill Stem Test (DST) is planned for the Zafarani-2 well. In the future other similar DSTs on some of the other wells will most likely have to be carried out. A drill stem test is a procedure used to determine the productive capacity and permeability of a potential hydrocarbon reservoir zone. The procedure for drill stem testing is as follows.

The drill ship *Discoverer Americas* will re-enter the Zafarani-2 well and drill through the cement plugs using WBM and perform two separate well tests. The cuttings will be disposed to the seabed, estimated to 50-60 m<sup>3</sup>. After the drilling is completed, some fluids will be needed to clean up the bore hole before entering in the testing equipment.

A DST tool is attached to the bottom of the drill string and lowered to a point opposite the formation to be tested. The DST tool is equipped with expandable seals (cement plugs/ packers) that permit the formation being tested to be isolated from the rest of the borehole (Figure 3-13). The drill pipe is also emptied (run in dry) of all drilling mud so formation fluid can enter into the drill string. The DST tool is closed off and the drill string is brought up to the surface. The contents inside the drill string are measured. The amount of gas or oil that flow into the drill string during the test and the recorded pressures are analysed to determine the productive capacity of the formation.

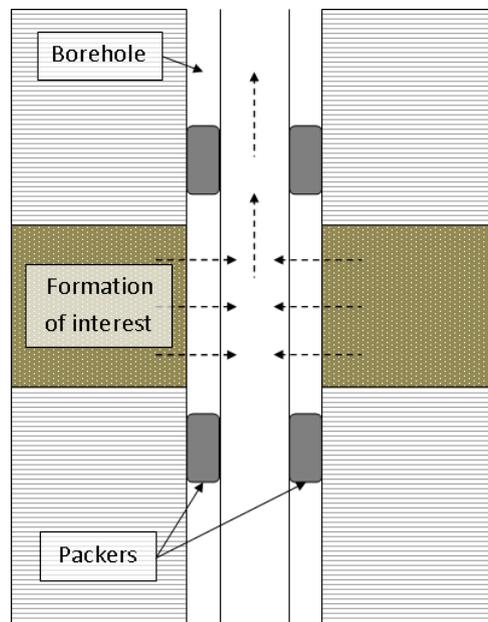


Figure 3-13. Schematic view of Drill stem testing.(Source:COWI).

During the well test the well fluid will be flared. Gas will be flared over the gas flare, and condensate and base oil on the dedicated burner. The expected maximum gas production rate is 1.7 million Sm<sup>3</sup>/day. Very small amount of condensate is expected. Approximately 20m<sup>3</sup> of base oil will be burnt off per test.

There is an uncertainty if there will be liquid components following the gas – or if the gas will be completely dry. This will be part of the objective of the test to clarify. The samples we have so far from the well indicates a Gas Oil Ratio (GOR) on 25000-70000, which means that up to 170 m<sup>3</sup> of condensate can be produced and burnt based on a total gas production of from 2,5 to 6 million m<sup>3</sup> per test. There is a preliminary assumption that quantities of condensate might be up to 350-400m<sup>3</sup>, and there is made arrangements to separate out these volumes from the gas flow and burn the potential amount. However, smaller volumes are expected and this will be clarified during the testing.

Methanol and MEG will be injected into the well stream to avoid hydrate formation. MEG will also be used in the brine and when pressure testing.

The injected chemicals will mix with the well stream and be burned.

225 m<sup>3</sup> MEG (Mono Ethylene Glycol) will be mixed into the brine to avoid hydrates and will be recovered from the brine.

It is planned to use high efficiency Evergreen burner head with very effective combustion. The fluids produced will be directed via the test process plant to the flare boom. In the initial phase of the well test the produced fluids will be collected in a tank. The fluids that can be burned will be pumped to the burner head; the remaining slop will be handled by the rig slop system or sent onshore for safe disposal.

During the well test, steam generators will be used to produce steam for heating of the well stream and compressors to produce air needed for combustion on the burner. An additional 25 m<sup>3</sup> of diesel could be used per test. Ship consumption is not included.

The burner and flare operation will be planned in a way to minimize fall out to sea. The flare radiation will be controlled by using dedicated water cooling on the burner boom and rig side. By nature a drill ship as Discoverer Americas have one boom and will change heading to ensure good conditions for burning.

The duration of the DST is estimated at 62 days. Estimated emissions to the air are shown in Table 7-27.

Table 3-7 show the amount of different chemicals that is planned to be used for the drill stem test and their Klif classification. The chemical planned to be used are either green or yellow. For other DST's a similar use of chemicals will be employed.

*Table 3-7 Chemicals planned to be used for the Zafarani-2 DST. Total usage and discharges of the different drilling mud components are indicated. Klif ratings are also indicated.*

Product name	Function	Total usage (Tonnes)	Total Discharged (Tonnes)	Klif Environmental classification
<b>WBM chemicals</b>				
Barite	Weighting material	667	667	Green
Bentonite	Viscosifier	233	233	Green
Soda ash	pH control	1	1	Green
Caustic soda	Alkalinity	1	1	Yellow
<b>NaCl Brine</b>				
Na Cl	Brine/Base Fluid	475	475	Yellow
Mono Ethylene Glycol (MEG)	Hydrate inhibitor	247	247	Green
BARACOR 100	Corrosion inhibitor	12	12	Yellow
STARCIDE	Biocide	1.5	1.5	Yellow
OXYGON	Oxygen Scavenger	1.5	1.5	Yellow
<b>Clean Up Pill Spacer</b>				
BARCLEAN DUAL	Surfactant for Clean Up	16	16	Yellow
BARAZAN D	Viscosifier	2	2	Yellow
Barite	Weighing agent	20	20	Green
Caustic soda	Alkalinity Source	1.5	1.5	Yellow
<b>Contingency</b>				
BARACLEAN GOLD	Surfactant for Pit cleaning	11	11	Yellow
DEXTRID LTE	Fluid Loss for LCM Contingency½	2	2	Yellow
Methanol	ROV injection	4	4	Green
BARACARB	LCM	4	4	Green

### 3.6 Decommissioning phase

The EMA of 2004 requires that the operator shall undertake safe decommissioning, site rehabilitation and ecosystem restoration before the closure of the project at

own cost. Drilling will cease when the well target depth (TD) is reached. The following measures will be taken:

- › The wells will be logged, and the coring may be undertaken. After completion, the wells will be plugged and abandoned. The BOP will be removed but the wellhead will remain on the sea floor. In some instances the wells may be temporarily plugged for later re-entering and conversion to production wells;
- › After completion of the abandonment procedures, the remote-control operated vehicle (ROV) will survey the seafloor to make sure that no unnecessary structure from the drilling and abandonment activity is left behind;
- › The drill ship will leave the location and all vessel transport related to the drilling will cease and
- › Disposing of all waste generated during last few weeks of operation.

## 3.7 Project alternatives

### 3.7.1 No project (no-go) alternative

The no-go alternative would mean no additional drilling for exploring other gas reserves in Block 2. This would leave the environment in Block 2 with the current exploration and appraisal wells at Zafarani, Lavani and Tangawizi. This would, however, limit Statoil's ability to identify further discoveries to increase gas volumes to sustain a robust resource base for the LNG-development. Further, the Tanzanian government and society will miss the substantial income of taxes, deliverables/employment etc. stemming from a development of these gas resources.

In addition Statoil have a license allowing them to explore within Block 2 for a limited amount of time. Therefore the no-go alternative will contradict the objectives of the license acquired.

### 3.7.2 Technological and process alternatives

#### 3.7.2.1. TYPES OF DRILLING FLUIDS

The choice of which drilling fluid to be used (seawater with sweeps, WMB or SOBM) depends on various factors such as drill depth, previous knowledge about the reservoir the characteristics of the sediments and reservoir (geology, temperature, pressure). SOBM has been chosen mainly i) to avoid hydrates and ii) to obtain optimal mud weight.

#### 3.7.2.2. TYPES OF CEMENT AND RIG CHEMICALS

The types of cementing and rig chemicals used are often standard and are used in offshore explorations in the North Sea, Qatar and other areas. The chemicals to be

used are to be assessed against Tanzanian legislation and international standards such as OSPAR recommendations on a Harmonised Offshore Chemical Notification Format (HOCNF) for chemicals used in the offshore oil and gas industry in Europe. Tanzanian legislation and the OSPAR recommendations are included in Appendix 5 and 6 respectively.

#### 3.7.2.3. HANDLING OF CUTTINGS WITH SOBM

Alternatives for using the existing solids control equipment on the *Discoverer Americas* (or other drill ship that may be employed in the future) and discharge the treated cuttings to sea with an oil content < 6.9 % include

- › Shipping of cuttings from the lower sections (when riser in place) to shore, for onshore treatment in a TCC plant;
- › Shipping of cuttings from the lower sections to shore, for laying out to dry; and disposed in a safe manner like transport to a cement factory
- › Installing a TCC-unit onboard the drill ship

These options are discussed in chapter 8.2.5.

If drilling more wells (five or more) at the same location (production wells), injection of cuttings into a dedicated injection well might be an option, but this is not an option for a single exploration well.

#### 3.7.2.4. WELL LOCATIONS

All additional explorations will take place within Block 2 and drilled where the potential hydrocarbons are expected to be located. Locations will be chosen to reduce costs, maximize efficiency in the operations and to ensure safe operations. Each location is inspected with the ROV prior to spudding to check for unforeseen conditions at the seabed.

The well locations can be generally divided into 3 areas: the Sea Gap, Davie Ridge and West Side. The first planned operations are located in the Sea Gap with well locations have been determined by Statoil's seismic surveys. Minor adjustments of location might be needed prior to spudding, if the ROV-survey identifies any obstacles.

### 3.7.3 Supply Port Base

The main ports in Tanzania that are used for marine facilities, transport and trade include Tanga, Dar es Salaam, Mtwara and Zanzibar. Other ports in neighbouring countries include Pemba in Mozambique and Mombasa in Kenya. Mtwara Port has been selected to support the deep-water drilling operations for Statoil because:

- › Mtwara is already being used by Statoil (and other offshore exploration companies) and have already established staff and other facilities in Mtwara;

- › Mtwara is the closest port to the planned explorations in Block 2, reducing costs of fuel and time;
- › Mtwara has already been rehabilitated to support offshore exploration drilling with storage areas, freshwater supply, and an operational Mud Plant for processing the drilling muds;
- › Other international ports would involve additional legislative complications;
- › TPDC has urged all operators to utilise Mtwara Port.

#### 3.7.4 Airport Support Base

Crew changes will be carried out by helicopter to and from the drill ship. Two alternative airports include Dar es Salaam and Mtwara airports. Dar es Salaam Airport has been selected for helicopter support as it is more convenient and efficient because some crew will arrive and depart through the same airport, and where necessary can be hosted temporarily in Dar es Salaam rather than having to travel and stay in Mtwara.

#### 3.7.5 Navigation route alternatives

It is not anticipated to change the current supply vessel and helicopter routes for future drilling operations. The helicopter and supply vessel routes chosen are the most direct that minimises fuel consumption and travel time, and avoids obstacles or sensitive marine habitats.

## 4 POLICY, ADMINISTRATIVE AND LEGAL FRAMEWORK

### 4.1 National policies, legislation and regulations

To ensure that the project complies with requirements, various policies, and environmental legislation and standards, which are relevant to this development have been identified and reviewed. Policy and standards of relevance cover Health, Safety and Environment (HSE) and the exploration and development of petroleum products.

In addition, various pieces of legislation relevant to this development have been identified. This section also addresses the legal and regulatory conditions, which are relevant to Statoil's proposed deep-water exploration drilling programme in Block 2. These statutory requirements relates to marine transport, HSE and the exploration and development of petroleum products.

#### 4.1.1 National policies

Relevant National policies include:

- › The National Environmental Policy of 1997 (Cf. Table 4-1)
- › The Fisheries Policy of 1997 (Cf. Table 4-1);
- › The HIV/AIDS Policy of 2001 (Cf. Table 4-1);
- › The National Sustainable Industrial Development Policy of 1996 (Cf. Table 4-2)
- › The National Energy Policy of 2003 (Cf. Table 4-2)

Table 4-1 National policies on Health, Safety and Environment

Name of policy	Brief description of relevance to environmental management and Statoil's operations
National Environmental Policy (1997)	<ul style="list-style-type: none"> <li>● The key objectives of the National Environmental Policy (NEP) are to: <ul style="list-style-type: none"> <li>&gt; Ensure sustainability, security and equity in the use of resources;</li> <li>&gt; Prevent and control degradation of land, water, vegetation and air resources;</li> <li>&gt; Conserve and enhance the natural and manmade heritage; and</li> <li>&gt; Raise awareness and promote public participation;</li> <li>&gt; Enhance international cooperation on the environmental agenda.</li> </ul> </li> <li>● NEP elaborates clearly the importance of EIA in the implementation of the NEP and recognises the importance of public consultations and hearings during the EIA process.</li> <li>● The policy advocates the use of other relevant environmental management approaches such as environmentally sound technologies, legislation, economic instruments, environmental standards and monitoring indicators.</li> <li>● The policy also promotes the protection of workers from environmental health hazards and the use of the 'polluter pays principle' and the 'precautionary principle'.</li> <li>● Therefore this EIS is in line with the NEP and has adhered to the principles in the policy with respect to public consultations; environmentally sound technologies, legislative and standard requirements and monitoring indicators.</li> </ul>
Fisheries Policy (1997)	<ul style="list-style-type: none"> <li>● The overall goal of the policy is to promote conservation, development and sustainable management of the fisheries resources for the benefit of present and future generations.</li> <li>● The policy promotes inter-sectorial co-operation to minimise operational conflicts for example coordination between the Deep Sea Fisheries Authority, TPDC and SUMATRA to avoid conflicts between offshore fisheries and exploration operations.</li> <li>● The Policy advocates for the protection of the productivity and biological diversity of coastal and aquatic ecosystems through the prevention of habitat destruction, pollution and over exploitation. This is relevant for Statoil to ensure that all their vessels and onshore contractors take appropriate measures to avoid habitat destruction and pollution. Statoil are continuing to invest in effective waste management so as to avoid marine pollution of their activities. In addition, Statoil have rigorous pollution standards regarding disposal of cuttings with SOBM.</li> </ul>
The HIV/AIDS Policy (2001)	<ul style="list-style-type: none"> <li>● The policy provides a framework for leadership and coordination of the National multi-sectorial response to the HIV/AIDS epidemic. The objectives of the policy include to; <ul style="list-style-type: none"> <li>&gt; Prevent transmission of HIV/AIDS by creating and sustaining an increased awareness of HIV/AIDS through targeted advocacy, information, education, and communication for behaviour change at all levels by all sectors.</li> <li>&gt; Promote early diagnosis of HIV infection through voluntary testing and provide pre-and-post test counselling.</li> <li>&gt; To care for people living with HIV/AIDS (PLHAs) by providing counselling and social support services for PLHAs and their families, combating stigma, ensuring adequate treatment and drugs and the use of community based care services.</li> </ul> </li> <li>● The policy recognises that HIV infection shall not be grounds for discrimination in relation to education, employment, health and any other social services.</li> <li>● Therefore Statoil has the responsibility to actively prevent transmission and promote early diagnosis and treatment for their employees and provide care for PLHAs if already employed (included as part of the mitigation measures in this EIS).</li> </ul>

Table 4-2 National policies on petroleum exploration and development

Name of policy	Brief description of relevance to environmental management and Statoil's operations
<b>National policies</b>	
The National Sustainable Industrial Development Policy (1996)	<ul style="list-style-type: none"> <li>• The Sustainable Industrial Policy advocates for sound environmental management as a means of promoting environmentally friendly and ecologically sustainable industrial development in Tanzania. The policy underscores the importance of carrying out EIA for new projects. Therefore Statoil by carrying out this EIA is in line with the policy.</li> </ul>
The National Energy Policy 2003	<ul style="list-style-type: none"> <li>• The national energy policy objectives are to ensure availability of reliable and affordable energy supplies and their use in a rational and sustainable manner in order to support national development goals. The national energy policy, therefore, aims to establish an efficient energy production, procurement, transportation, distribution and end-use systems in an environmentally sound and sustainable manner.</li> <li>• With respect to the petroleum and natural gas industry, operations are to be undertaken ensuring highly established standards for environment, safety, health, and product quality. Environmental impact assessments and environmental management plans are mandatory for all energy programmes and projects.</li> <li>• The policy also promotes energy efficiency and conservation as a means towards pollution control measures, disaster prevention and response plans and standards for exploration activities.</li> <li>• Therefore Statoil is adhering to the energy policy by conducting this EIA and already has internal environmental standards and response plans for emergency oil spills.</li> </ul>



#### 4.1.2 Principle legislation

Relevant principle legislation includes:

- › Environmental Management Act of 2004 (Cf. Table 4-3);
- › Fisheries Act of 2003 (Cf. Table 4-3);
- › Water Resources Management Act of 2009 (Cf. Table 4-3);
- › Occupational Health and Safety Act of 2003 (Cf. Table 4-3);
- › Public Health Act of 2009 (Cf. Table 4-3);
- › The Water Supply and Sanitation Act of 2009 (Cf. Table 4-3);
- › Disabilities Act of 2010 (Cf. Table 4-3);
- › The HIV and AIDS (Prevention And Control) Act (2008) (Cf. Table 4-3);
- › The Merchant Shipping Act of 2003 (Cf. Table 4-4);
- › Petroleum (Exploration and Production) Act of 1980 (Cf. Table 4-4);
- › The Territorial Seas and Exclusive Economic Zone Act (1989) (Cf. Table 4-4)
- › The Industrial and Consumer Chemicals (Management and Control) Act of 2003 (Cf. Table 4-4).

Table 4-3 National legislation Health, Safety and Environment

Name of legislation	Brief description of relevance to environmental management and Statoil's operations
Environmental Management Act (2004)	<ul style="list-style-type: none"> <li>● The Environmental Management Act (EMA) Cap 191 (2004) seeks to provide for legal and institutional framework for sustainable management of the environment in the implementation of the National Environmental Policy. The Act defines environment as "the physical factors of the surroundings of human beings, including air, land, water, climate, sound, light, odor, taste, micro-organism, the biological factors of animals and plants, cultural resources and the social economic; factor of aesthetics and includes both the natural and the built environment and the way they interact".</li> <li>● Section 4(1) of the Act requires that any development project be subjected to an EIA in accordance to the regulations under the Act in order to determine whether or not a programme, activity or project will have any adverse impacts on the environment. Amongst the principles, the Act advocates for public participation, minimization of waste, safe disposal of waste, and the prevention of air, water and land pollution.</li> <li>● The Act provides for environmental standards related to water quality, discharge of effluent into water bodies, soil quality, air quality, control of noxious smells, control of noise and vibration pollution that very person undertaking any activity shall be required to comply with environmental quality standards and criteria.</li> <li>● Therefore Statoil is in compliance with the EMA by the completion of this EIA that includes an environmental management plan and monitoring plan to uphold the environmental standards under the Act.</li> </ul>
Fisheries Act (2003)	<ul style="list-style-type: none"> <li>● The Act focuses on development and sustainable use of aquatic resources, their management, and to maintain and improve standards and quality within the fishing industry. Section 22(1) of the Act stipulates that no person shall engage in: Fishing; Collecting, gathering, processing or manufacturing fish products or products of aquatic flora; Selling or marketing of fish, fish products, aquatic flora or products of aquatic flora; Importing or exporting of fish, fish products, aquatic flora or products of aquatic flora;</li> </ul> <p>Unless he applies for and is granted by the Director or any other Authorized officer a licence in respect of such activity. No licence or permit is required for fishing for prawns using cloth; using small cast nets; or using rod and line or hand line from the beach without using a fishing vessel whether for sport fishing, domestic consumption or sale</p> <ul style="list-style-type: none"> <li>● Section 53 (1) and 54 of the Act promotes research and information sharing among stakeholders and the various government and research institutions mandated with implementation of the Act (Ministry of Livestock and Fisheries, Tanzania Fisheries Research Institute TAFIRI, Deep Sea Fisheries Authority DSFA).</li> <li>● Statoil is to therefore monitor that none of their contractors engage in fishing activities unless they acquire a permit to do so, and is encouraged to share information gathered during their offshore explorations related to fishing with respective authorities.</li> </ul>
Water Resources Management Act (2009)	<ul style="list-style-type: none"> <li>● Section 4 (1). The objective of this Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled. Section 7 of the Act states that it is the duty of every person residing in Mainland Tanzania to safeguard and protect water resources and to inform the relevant authority of any activity and phenomenon that may affect the quantity and quality of the water resources significantly. Section 9 (Cap 191) requires any proposed development in water resource area or watershed to which this Act applies, whether that development is proposed by or is to be implemented by a person or organization in the public or private sector shall carry out an Environmental Impact Assessment in accordance with the provisions of the EMA</li> <li>● Article 39 elaborates on the need to prevent pollution and the penalties to be taken against one who pollutes the water resources. Section 63(1) stipulates that a Discharge Permit is required for any person who wishes to discharge effluents from any commercial, industrial or agricultural source or from any sewerage works or trade waste systems or from any other source into surface water or underground strata.</li> <li>● The supply of water for Statoil's offshore explorations is provided via the Mtwara Supply Base packaged into containers therefore no permit is required for water supply. However Statoil is to ensure that their waste management contractor has a discharge permit for all treated effluents from the offshore activities that are disposed of onshore.</li> </ul>
Occupational Health and Safety Act (2003)	<ul style="list-style-type: none"> <li>● This act deals with the protection of human health from occupational hazards. Section 62 specifically requires the employer to ensure the safety of workers by providing safety gear at the work place.</li> <li>● Section 16 and 17 of the Act requires a factory or workplace to be inspected for the provision of the minimal legal requirements for workers health and safety and to be issued a registration certificate (at the cost of the owner/occupier).</li> <li>● Key health and safety aspects for Statoil to provide for their employees and contractors include (but are not limited to): Safety with operating and maintaining machinery, Safety with hoisting and lifting, Health protection in relation to hazardous and toxic substances, fumes, gases, dust, Safety in handling, labelling, storing and disposal of chemicals so as not to harm human health and environment,</li> </ul>

	<p>Fire prevention and rescue, Employee access to adequate supply of clean, safe and wholesome drinking water, Provision of sufficient and suitable separate sex sanitary conveniences, First aid facilities, Resting facility, Accessibility and facilities for people with disabilities.</p> <ul style="list-style-type: none"> <li>● Section 11 (1) and 12 (1) of the Act provides for owners/occupiers of a factory or workplace to have health and safety representatives responsible for the management of their internal Occupational Health and Safety Plan and reporting. Statoil already has internal HSE officers that monitor the implementation of their Health, Safety and Environment Policy (Appendix 2) and an Emergency Response Plan (Appendix 3).</li> </ul>
Public Health Act (2009)	<ul style="list-style-type: none"> <li>● The Act provides for the promotion, preservation and maintenance of public health with a view to ensuring the provisions of comprehensive, functional and sustainable public health services to the general public.</li> <li>● In relation to ports, section 37 to 38 prohibits a person to Discharge into waters of the seaport, lake port or river port, any oil, grease, ballast, waste, sewage or any other substance likely to pollute the water or the coastline which may be detrimental to navigation or cause any inconvenience to the shipping industry, aquatic life and recreational activities which may create any health hazard to the public. Dump or discharge or cause to be dumped or discharged any waste, either solid or liquid or any other substance which may cause or likely to cause pollution into the land within the defined port area.</li> <li>● Section 92 prohibits the disposal of hazardous waste on land or water unless and Environmental Health Impact Assessment is conducted according to the EMA. Hazardous waste is defined by the Act as "any solid, liquid, gaseous or sludge waste which by reason of its chemical reactivity, environmental or human hazardousness, infectiousness, toxicity, explosiveness and corrosiveness is harmful to human health, life and environment".</li> <li>● Section 39 of the Act states that where there is a danger to public health, the Port Health Officer may, in consultation with other related authorities, order the detention of passengers animals, cargo, storage, goods, maintenance or cessation of other operations at any port or section</li> <li>● In relation to solid and liquid waste management, section 73 (1), 73 (4) and 73 (5) of the Act requires the Authority or the contracted agent to collect, treat and dispose waste at designated areas manage the disposal areas to control the occurrence of scavengers, nuisance or disease, and provide their employees with relevant protective gears Statoil has a contractor responsible for managing waste who has is responsible for acquiring the relevant permits from the authorities and has a waste management plan (Appendix 4) that shows how waste is collected, transferred, treated and disposed of. Statoil is therefore responsible for monitoring the contractor in collaboration with the Mtwara Mikindani Municipal Council.</li> </ul>
The Water Supply and Sanitation Act of 2009	<ul style="list-style-type: none"> <li>● Section 4 and 9 of the Act provides for the sustainable management and adequate operation and transparent regulation of water supply and sanitation services. It also establishes Water Authorities responsible for the efficient and economical supply of water and sanitation services within their defined boundaries that can overlap more than one local government jurisdiction.</li> <li>● Statoil offices in Mtwara Mikindani are found within the Mtwara Port therefore their source of water supply and sanitation services is from an existing network.</li> </ul>
Disabilities Act (2010)	<ul style="list-style-type: none"> <li>● The Act provides for the health care, social support, accessibility, rehabilitation, education, protection, employment and basic rights for persons with disabilities. The Principles of this Act as in Section 4 include <ul style="list-style-type: none"> <li>&gt; Respect for human dignity, individual's freedom to make own choices and independency of persons with disabilities;</li> <li>&gt; Non-discrimination;</li> <li>&gt; Full and effective participation and inclusion of persons with disabilities in all aspects in the society;</li> <li>&gt; Equality of opportunity;</li> <li>&gt; Accessibility;</li> <li>&gt; Equality between men and women with disabilities and recognition of their rights and needs; and</li> <li>&gt; Provide basic standard of living and social protection.</li> </ul> </li> <li>● Therefore Statoil is to ensure that the above principles are adhered to in all their operations.</li> </ul>
The HIV and AIDS (Prevention And Control) Act (2008)	<ul style="list-style-type: none"> <li>● Section 4(1) of the Act requires every institution living, registered or operating in Tanzania to Promote public awareness on causes, transmission, consequences, prevention and control of HIV and AIDS,</li> </ul>

	<p>Reduce the spread and adverse effects of HIV and AIDS, Protect the rights of orphans, Discourage negative traditions and usages which enhance the spread of HIV and AIDS, Increase access, care and support to persons living with HIV and AIDS (PLHAs),</p> <ul style="list-style-type: none"> <li>● Section 9 of the Act requires every employer in consultation with the Ministry of Health to establish and coordinate a workplace programme on HIV AIDS for employees. In addition employers are not to stigmatize or discriminate in any manner any person against PLHAs.</li> </ul>
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Table 4-4 Legislation on Marine transport

Name of Legislation	Brief description of relevance to environmental management and Statoil's operations
The Merchant Shipping Act, (2003)	<ul style="list-style-type: none"> <li>● The purpose of the Act is to regulate shipping and provides for registration and licensing of ships, the engagement of seafarers, prevention of collisions at sea, safety of navigation, and safety of life at sea.</li> <li>● The Act prohibits any foreign ship to <ul style="list-style-type: none"> <li>&gt; Section 10 (1): Trade in or from the waters of Tanzania unless provided with a certificate of foreign registry</li> <li>&gt; Section 11 (2) and 11 (3): Anchor in or trading in or from Tanzanian waters or entering a port in Tanzania unless it has insurance cover against risks of loss or damage to third parties. The insurance cover against risks of loss or damage to third parties is to be adequate to cover liabilities as referred to under section 352 of this Act.</li> </ul> </li> <li>● Section 110 requires any person wishing to engage or recruit a Tanzanian seafarer for employment on board a Tanzanian or foreign ship, to first obtaining a licence authorizing such person to engage or recruit Tanzanian seafarers for the sea service. The Act also makes provision for the protection of seamen in terms of employment, welfare and wages that are to be stipulated in regulations made by the Minister responsible.</li> <li>● Section 195 of the Act stipulates that foreign vessels are to observe the Collision Regulations within Tanzanian waters, and in any case before a Court in Tanzania concerning a breach of Collision Regulations arising within Tanzanian waters, foreign ships and seaplanes shall be treated as if they were Tanzanian ships and seaplanes registered in Tanzania. ("Collision Regulations" means the international Convention on Regulations for the Prevention of Collisions at Sea, 1972)</li> <li>● Section 229 (4 to 5) of the Act requires that all ships while in Tanzanian waters and all companies in relation to ships are to comply with the International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention adopted by the IMO.</li> <li>● Section 369 (1) and Section 370 of the Act prohibits oil or oily mixture shall be discharged from a Tanzanian tanker or other ship within any of the prohibited zones or from a foreign tanker or other ship within the prohibited zone adjoining the territories of Tanzania with the exception if the discharge is to secure the safety of the ship or is a result of unavoidable damage or leakage.</li> <li>● Statoil is to ensure that all vessels used in the drilling programme comply with the provisions of the Act.</li> </ul>

Table 4-5 National legislation on Petroleum exploration and development

Name of Legislation	Brief description of relevance to environmental management and Statoil's operations
Petroleum (Exploration and Production) Act (1980)	<ul style="list-style-type: none"> <li>● Petroleum exploration and production in Tanzania is governed by this Act and applies to any naturally occurring hydrocarbon, whether in gaseous, liquid or solid state or any mixtures thereof.</li> <li>● Section 14 of the Act vests title to petroleum deposits within Tanzania in the State and permits the Government to enter into a petroleum agreement under which a company may be granted exclusive rights to explore for and produce petroleum.</li> </ul>

	<ul style="list-style-type: none"> <li>● The Act is the basis for the granting of exploration and development licenses. The registered holder of an exploration licence may apply for the extension of the licence in respect of any blocks in the exploration area as in Section 26(1)</li> <li>● Section 31 (1) of the Act requires that the holder of the exploration licence to inform the authorities of any discoveries and within a period of thirty days after the date of the discovery, furnish to the Minister particulars in writing of the discovery</li> <li>● Section 62(1) restricts a registered holder of a licence to drill a well any part of which is less than one thousand metres from a boundary of the area subject to the licence except with the consent in writing of the Commissioner and in accordance with such conditions, if any, as are specified in the instrument of consent.</li> <li>● Statoil already has the required licenses and has furnished information of previous discoveries to the authority's in compliance with the Act.</li> </ul>
<p>The Territorial Seas and Exclusive Economic Zone Act (1989)</p>	<ul style="list-style-type: none"> <li>● This Act makes provision for the implementation of the Law of the Sea Convention, to establish the territorial sea and to establish an The Exclusive Economic Zone (EEZ) of the United Republic adjacent to the territorial sea</li> <li>● In EEZ Part V, Article57 (1) outlines that the State has sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living non-living, of the waters superjacent to the sea-bed and of the sea-bed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds.</li> <li>● Article 60 (1) allows for the State to construct and to authorize and regulate the construction, operation and use of installations and structures for economic purposes.</li> <li>● Statoil's drilling activities are within Tanzania's EEZ and have acquired the relevant licence to operate the drill ship as per the Act and as per the Petroleum (Exploration and Production) Act.</li> </ul>
<p>The Industrial and Consumer Chemicals (Management and Control) Act (2003)</p>	<ul style="list-style-type: none"> <li>● Section 9 and 15 (1) of the Act requires that any person or entity intending to produce, import, export, transport, store or deal in chemicals needs to register with the Government Chemist for those chemicals listed in the Third Schedule of the Act that area above the specified threshold provided by the Government Chemist. Section 29 (1) of the Act stipulates that a certificate is issued upon satisfaction of a site inspection after registration of the premise(s).</li> <li>● Section 4, 16 and 46 (1) of the Act requires the person or entity to             <ul style="list-style-type: none"> <li>&gt; Register the premises and also describe the equipment and facilities which are available,</li> <li>&gt; Describe the qualifications of personnel responsible for the chemicals,</li> <li>&gt; Provide arrangements made or to be made for the safety, health and environment within and outside the premise including appropriate labelling and safe handling procedures,</li> <li>&gt; Provide contingency plan and procedure dealing with emergency,</li> <li>&gt; Describe arrangements or to be made for securing the safety and maintenance of records in respect of chemicals stored,</li> <li>&gt; Take steps and precautions to ensure that accumulation of chemical wastes, spillages and contamination of the environment is avoided.</li> <li>&gt; Ensure the safe and environmentally sound disposition of any chemical wastes generated.</li> </ul> </li> <li>● Drill chemicals will be stored at the Mtwara Port Base and transported to the drill ship according to needs. The Mtwara Port base is under the MUFA. Therefore all relevant registrations and HSE plans and management at the Port is under the responsibility of the current operator of MUFA which is British Gas.</li> </ul>



### 4.1.3 Regulations

Relevant regulations include:

- › General Tolerance Limits for Municipal and Industrial Wastewaters (TZS 860:2005) (Cf. Table 4-6);
- › Air Quality Specification (TZS 845:2005) (Cf. Table 4-6);
- › Environmental Management (Solid Waste Management) Regulations, 2008 (Cf. Table 4-6);
- › Environmental Management (Hazardous Waste Control and Management) Regulations, 2008 (Cf. Table 4-6);
- › Environmental Management (Water Quality Standards) Regulations, 2008 (Cf. Table 4-6);
- › National Marine Oil Spill Response Contingency Plan (Draft) (2010) (Cf. Table 4-6);
- › Merchant Shipping (Training Certification and Manning) Regulations (2004) (Cf. Table 4-7)
- › Merchant Shipping (Ship and port Facility Security) Regulations (2004) (Cf. Table 4-7).

Table 4-6 National Regulations Health, Safety and Environment

Name of regulation	Brief description of relevance to environmental management and Statoil's operations
General Tolerance Limits for Municipal and Industrial Wastewaters (TZS 860:2005)	<ul style="list-style-type: none"> <li>● This Tanzania standard is applicable to effluents discharged from all establishments. The standard prescribes the permissible limits for municipal and industrial effluents discharged directly into water bodies (Appendix 5).</li> <li>● The effluent parameters contained herein include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Colour, pH, Temperature, Total Suspended Solids (TSS) and Turbidity.</li> <li>● Also this standard gives permissible limits for Inorganic substances e.g. Aluminium (as Al), Arsenic (As), Barium (Ba), Cadmium (Cd), Chlorides (Cl-), Total Phosphorus ( as P), (SO4-), etc. ; Organic substances including hydrocarbons, aromatic amines, alkyl benzene sulfonate (ABS), Oil and Grease (Petroleum Ether Products) and pesticides; Microbiological coliform organisms.</li> <li>● Therefore Statoil is to ensure that all their contractors i.e. drill ship and onshore waste management contractor are adhering to the permissible limits with respect to waste water discharge; that effluent is treated onsite prior to discharge; and that effluents are not discharged in close proximity to water supply sources and recreational areas.</li> </ul>
Air Quality Specification (TZS 845:2005)	<ul style="list-style-type: none"> <li>● This Tanzania Standard gives permissible limits of some common substances found in polluted air, namely sulphur dioxide, carbon monoxides, suspended particulate matter (dust), oxides of nitrogen, hydrocarbons, and lead (Appendix 5). The standard covers both The ambient air including sulphur dioxides, carbon monoxide, black smoke and suspended particulate matters, nitrogen dioxide, lead and ozone; and Emission sources including sulphur dioxides, carbon monoxide, hydrocarbons, dust, nitrogen oxides and lead.</li> <li>● Therefore Statoil is to ensure that all their contractors i.e. drill ship and onshore waste management contractor are adhering to the permissible limits with respect to emissions to air.</li> </ul>
Environmental Management (Solid Waste Management) Regulations, 2008	<ul style="list-style-type: none"> <li>● The Regulations requires licences or permits for <ul style="list-style-type: none"> <li>&gt; Any person wishes to deal in solid waste as collector, transporter, depositor or manager of transfer station s (Section 9 (1))</li> <li>&gt; Individuals and or companies to operate solid waste disposal sites that are renewable every two years.-Section 12 (1) and Section 12 (2)</li> </ul> </li> <li>● This licence according to the second schedule of the regulations is to be issued via the local government authority (LGA) after the completion of an EIA.</li> <li>● Section 14 (a) and 15 (1) of the regulations require separation of solid waste at the source and collected into separate waste storage receptacles approved by NEMC or by the LGA</li> <li>● The regulations promotes the re-use, recycling and composting of waste where ever possible and lists method of treatment, recycling and final disposal for various types of waste in the First Schedule of the regulations.</li> <li>● Statoil is using an agent to manage all their waste, therefore the duty to apply for licenses will fall on contracted agent. However Statoil is to monitor that the agent is adhering to the necessary requirements.</li> </ul>
Environmental Management (Hazardous Waste Control and Management) Regulations, 2008	<ul style="list-style-type: none"> <li>● Part I Cap 191 "Hazardous Substance" of the regulations define hazardous waste as any solid, liquid, gaseous or sludge waste which by reason of its chemical reactivity, environmental or human hazardousness, its infectiousness, toxicity, explosiveness and corrosiveness is harmful to human health, life or environment.</li> <li>● The regulations specify how hazardous waste shall be <ul style="list-style-type: none"> <li>&gt; Classified (criteria are listed in the Third Schedule).</li> <li>&gt; Packaged or stored- the container or package in which waste is to be contained is to be UN approved.</li> <li>&gt; Labelled that should show the type of waste, name and address of generator of waste, net content, storage stability, name and percentage by weight of other ingredients, first aid measures, directions for handling and warning or caution statements e.g. "CAUTION"/" POISON", etc., and directions for the disposal.</li> <li>&gt; Transported.</li> </ul> </li> <li>● Section 16 requires any person who intends to dispose or treat hazardous waste to apply to the Director of Environment for a licence in the form set out in the Fifth Schedule to these Regulations;</li> <li>● Section 48 requires and EIA to be conducted to any hazardous waste treatment plant or disposal site in order for it to be licensed and the plant/site shall be subject to an annual audit of the environmental performance to be reported to NEMC.</li> </ul>

	<ul style="list-style-type: none"> <li>● Statoil is using an agent to manage all their waste, therefore the duty to apply for licenses will fall on contracted agent. However Statoil is to monitor that the agent is adhering to the necessary requirements.</li> </ul>
<p>Environmental Management (Water Quality Standards) Regulations, 2008</p>	<ul style="list-style-type: none"> <li>● Section 4 (1-e) part i-viii of the regulations allow for the Tanzania Bureau of Standards to establish minimum quality standards for             <ul style="list-style-type: none"> <li>&gt; (i) Drinking water;</li> <li>&gt; (ii) Water for agricultural purposes;</li> <li>&gt; (iii) Water for recreational purposes;</li> <li>&gt; (iv) Water for fisheries and wildlife purposes;</li> <li>&gt; (v) Water for industrial purposes;</li> <li>&gt; (vi) Water for environment;</li> <li>&gt; (vii) Water for any other purposes;</li> <li>&gt; (viii) Effluent from domestic, agricultural, trade or industrial origin</li> </ul> </li> <li>● Section 6(1) of the regulations prohibit any person to discharge any hazardous substance, chemical, oil or mixture containing oil in any waters except in accordance with what is prescribed under these Regulations or any other written law.</li> <li>● Under the regulations, section 19 (7) a to c requires NEMC to issue discharge permits for water polluting activities and in determining whether or not to issue the permit NEMC or any other person empowered to make the decision shall:             <ul style="list-style-type: none"> <li>&gt; (a) refer to any guide from conduct of Environmental Impact Assessment and Environmental Audit.</li> <li>&gt; (b) consider the cumulative effect on the environment likely to result from any such grant; and</li> <li>&gt; (c) seek to ensure that the prescribed best practicable option is adopted.</li> </ul> </li> <li>● Statoil is using an agent to manage all their waste, therefore the duty to apply for licenses will fall on contracted agent. However Statoil is to monitor that the agent is adhering to the necessary requirements.</li> </ul>
<p>National Marine Oil Spill Response Contingency Plan (Draft) (2010)</p>	<ul style="list-style-type: none"> <li>● The purpose of this plan is to ensure that there is a timely, measured and effective response to incidents. The Objectives of this plan are:             <ul style="list-style-type: none"> <li>To develop appropriate systems for the rapid detection and reporting of spillages of oil or other noxious materials or of incidents related to the operation of shipping which could result in such a spillage;</li> <li>To ensure prompt response is made to either prevent pollution or restrict the spread of the contaminants;</li> <li>To ensure that adequate protection is provided for the public health and welfare and the marine environment;</li> <li>To ensure that the appropriate response techniques are used to clean up the pollutant and that disposal of recovered material is carried out in an environmentally acceptable manner; and</li> <li>To ensure that complete and accurate records are maintained for all expenditures to facilitate cost recovery.</li> </ul> </li> <li>● The owners and masters of ships and the operators of offshore installations bear the primary responsibility for ensuring that they do not pollute the sea. Harbor authorities are likewise responsible for ensuring that their ports operate in a manner that avoids marine pollution, and for responding to incidents within their limits. Statoil already has oil spill response kits on their contracted vessels and on Mafia Island in preparedness to respond to such emergencies.</li> </ul>

Table 4-7 National Regulations marine transport

Name of Regulations	Brief description of relevance to environmental management and Statoil's operations
<p>Merchant Shipping (Training Certification and Manning) Regulations (2004)</p>	<ul style="list-style-type: none"> <li>● Section 2 (4) parts a, b and c of the regulations specify that an officer on a ship is to hold a certificate of competency for the following posts: master, Chief mate, Officer in charge of a navigational watch, Chief engineer officer, second engineer officer, Officer in charge of a navigational watch, or Radio operator. Certificates issued under the authority of another party to the International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978 as amended by the conference of 1995 ('STCW Convention') are also recognised.</li> <li>● The regulations also outline the qualifications required for deck officers, engineering officers and cooks, which require minimum number of months on sea service, first</li> </ul>

	<p>aid and fire safety and fighting</p> <ul style="list-style-type: none"> <li>● Section 56 (1) parts a, b and c of the regulations require that every company to ensure that: <ul style="list-style-type: none"> <li>&gt; (a) every seaman assigned to any of its ships holds an appropriate certificate in respect of any function he is to perform on that ship;</li> <li>&gt; (b) every seaman on any of its ships has had training specified in the regulations in respect of any function he is to perform on that ship; and</li> <li>&gt; (c) documentation and data relevant to all seamen employed on its ships are maintained and readily available for inspection and include, without being limited to, documentation and data on their experience, training, medical fitness and competency in assigned duties.</li> </ul> </li> <li>● Statoil is to communicate the relevant requirements to the contractor for the supply vessels and the drill ship to ensure that they are in compliance with the regulations.</li> </ul>
Merchant Shipping (Ship and port Facility Security) Regulations (2004)	<ul style="list-style-type: none"> <li>● The regulations set out duties and functions of institutions responsible for the security of ships</li> <li>● Section 25 (1) and 25 (2) of the regulations require that port facilities have a Port Facility Security Officer and that the facility has security procedures that are updated.</li> <li>● The regulations require that all ships <ul style="list-style-type: none"> <li>&gt; Comply with the State's security level prior to entering a port or whilst in a port within the Tanzanian's territorial waters –Section 11 (2)</li> <li>&gt; Comply with the requirements of the ISPS Code (International Code for the Security of Ships and of Port Facilities, as adopted, on 12 December 2002, by resolution 2 of the Conference of Contracting Governments to the International Convention for the Safety of Life at Sea, 1974)-Section 11 (1)</li> <li>&gt; Shall have a security alert system that can send notifications to the national registrant of ships (SUMATRA)-Section 12 (2)</li> </ul> </li> <li>● Statoil is to communicate the relevant requirements to the contractor for the supply vessels and the drill ship to ensure that they are in compliance with the regulations.</li> </ul>

## 4.2 International Agreements and Conventions

Tanzania is a Party to a number of International Conventions. Table 4-8 outlines relevant conventions for a project of this nature.

Table 4-8 Relevant International Conventions

Convention	Relevance
International Convention for the Prevention of Pollution from Ships (MARPOL), 1973	Prevention of pollution of the marine environment by ships from operational or accidental causes. Provides regulations for the prevention of pollution by Oil (Annex I); by Noxious Liquid Substances in Bulk (Annex II); by Sewage from Ships (Annex IV); by Garbage from Ships (Annex V) and prevention of Air Pollution from Ships (Annex VI)
International Convention for the Safety of Life at Sea (SOLAS), 1974	Specifies minimum standards for the construction, equipment and operation of ships, compatible with their safety. It provides for <ul style="list-style-type: none"> <li>&gt; specifications on Fire protection, fire detection and fire extinction (Chapter II),</li> <li>&gt; requirements for life boats, rescue boats and life jackets according to type of ship (Chapter III),</li> <li>&gt; type of radio communication equipment designed to improve the chances of rescue following an accident (chapter IV),</li> <li>&gt; a safety management system to be established by the ship-owner or any person who has assumed responsibility for the ship (Chapter IX),</li> </ul>
The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	To reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs)
Bamako Convention on the ban on the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa	A treaty of African nations prohibiting the import of any hazardous (including radioactive) waste
Nairobi Convention or Convention of the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region	Provides a mechanism for regional cooperation, coordination and collaborative actions in the Eastern and Southern African region for the protection, management and development of coastal and marine environment including critical national and transboundary issues
Convention on the Conservation of Migratory Species of Wild Animals or BONN Convention	To conserve terrestrial, marine and avian migratory species throughout their range
Convention on Biological Diversity (CBD)	Provides for national strategies for the conservation and sustainable use of biological diversity
Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat)	Conservation and sustainable utilization of wetlands including sea grass beds and coral reefs
International Labour Organization (ILO) Convention: C148 Working Environment (Air Pollution, Noise and Vibration) Convention, 1977	Protects Workers Against Occupational Hazards in the Working Environment Due to Air Pollution, Noise and Vibration.
ILO Convention: C138 Minimum Age Convention, 1973	Prohibits child labour

## 4.3 Administrative framework

The Vice President’s Office (VPO) has overall responsibility for environmental policy formulation –including coordination and monitoring of National Environmental Management Council (NEMC) activities. However, respective ministries are responsible for environmental planning, management and monitoring

of projects under their jurisdiction and sector and report to the VPO's reports on the state of the environment in the country (Table 4-9).

Table 4-9 Summary of relevant institutions and their responsibilities

Level	Institution	Roles and responsibility
National	Ministry of Energy and Minerals	<ul style="list-style-type: none"> <li>&gt; Issue policy guidance and provision of legal frameworks</li> <li>&gt; Issue licenses, provisions of certificates of compliance</li> <li>&gt; Enforce laws and regulations related to gas exploration and development</li> <li>&gt; Set operation standards for sector projects</li> <li>&gt; Project monitoring</li> </ul>
	NEMC	<ul style="list-style-type: none"> <li>&gt; General supervision and coordinating over all matters related to environmental management.</li> <li>&gt; Conduct environmental audit and monitoring</li> <li>&gt; Conduct surveys to assist proper management and conservation</li> <li>&gt; Review/recommend for approval of environment impact statements</li> <li>&gt; Enforce/ensure compliance of national environmental quality standards</li> <li>&gt; Initiate/develop procedures/safeguards for prevention of accidents causing environmental degradation and evolve remedial measures if accidents</li> </ul>
	Director of the Environment ( Vice President's Office Division of Environment)	<ul style="list-style-type: none"> <li>&gt; Coordinate various environment management activities in country</li> <li>&gt; Advise the Government on legislative and other measures for the management of the environment</li> <li>&gt; Issues guidelines related to environmental management</li> <li>&gt; Advise Government on international environmental agreements and transboundary environmental management issues.</li> <li>&gt; Monitor and assess activities, being carried out by relevant agencies in order to ensure that the environment is not degraded</li> <li>&gt; Coordinate implementation of the National Environmental Policy and EMA</li> <li>&gt; Coordinates intersectoral plans and environmental management issues</li> </ul>
	Ministry of Natural Resources and Tourism	<ul style="list-style-type: none"> <li>&gt; Manage marine parks through Marine Parks and Reserves Unit (including Mnazi Bay-Ruvuma Estuary Marine Park, and Mafia Island Marine Park) and other Marine Protected Areas (MPAs)</li> <li>&gt; Manage RAMSAR Convention sites (Kilwa-Mafia-Rufiji)</li> </ul>
	Ministry of Livestock and Fisheries Development	<ul style="list-style-type: none"> <li>&gt; Overall management, supervision and monitoring of fishing activities in Tanzania</li> <li>&gt; Issue policy guidance and implementation of legal frameworks</li> <li>&gt; Enforce laws and regulations related to fisheries</li> </ul>
	Tanzania Petroleum Development Council (TPDC)	<ul style="list-style-type: none"> <li>&gt; Key partners for international companies in oil and gas exploration and development in Tanzania.</li> <li>&gt; Provide basic information on hydrocarbon exploration/ prospects</li> <li>&gt; Set quality/safety standards to protect people, property/environment</li> <li>&gt; Project monitoring</li> </ul>
	OSHA	<ul style="list-style-type: none"> <li>&gt; Registration and compliance on safety</li> </ul>
	SUMATRA	<ul style="list-style-type: none"> <li>&gt; Established under the Surface &amp; Marine Transport Regulatory Authority (SUMATRA) Act, (2001)</li> <li>&gt; Enforce maritime safety and pollution prevention</li> </ul>

		<ul style="list-style-type: none"> <li>&gt; Regulate marine transport routes, safety and security.</li> <li>&gt; Regulates and monitors marine vessels in Tanzanian waters including the registration of vessels, issuance of licences and manning and certification of seafarers on vessels.</li> </ul>
	National Navy	<ul style="list-style-type: none"> <li>&gt; Provide security of vessels within Tanzanian Waters</li> <li>&gt; Set security levels and ensure the provision of security level information to ships operating in the territorial sea of the United Republic of Tanzania or having communicated an intention to enter the territorial sea.</li> </ul>
	Deep Sea Fishing Authority	<ul style="list-style-type: none"> <li>&gt; Established under the Deep-sea Fishing Authority (Amendment) Act (2007)</li> <li>&gt; Monitoring and surveillance in EEZ beyond 12 nautical miles</li> <li>&gt; Communication and coordination of matters related to deep sea together with other stakeholders,</li> </ul>
Regional	Regional Secretariat Offices (Mtwara & Lindi)	<ul style="list-style-type: none"> <li>&gt; Oversee/advise implementation of national policies</li> <li>&gt; Oversee enforcement of laws and regulations</li> <li>&gt; Advise on implementation of development projects/activities</li> </ul>
	Local Government Authority Functional Departments and Committees: Economic planning; Planning ; Natural Resources; Health; Community Development ;Environment, etc.	<ul style="list-style-type: none"> <li>&gt; Coordinate environmental, economic and social matters at the Municipal / District level</li> <li>&gt; Enforce laws and regulations</li> <li>&gt; Provide baseline data on social and economic conditions</li> <li>&gt; Undertakes or contracts an agent to undertake solid and liquid waste management which includes collection, sorting, treatment and disposal at designated areas (including hazardous waste)</li> </ul>
	Tanzania Ports Authority (Mtwara Port)	<ul style="list-style-type: none"> <li>&gt; Established under the Tanzania Ports Act of 2004 to promote effective management and operations of sea and inland ports, provide cargo and passenger loading and unloading services, to develop and manager port infrastructure and maintain port safety.</li> <li>&gt; Port Manager (under the Public Health Act) oversees public health on the port in terms of clean water, disposal of waste, control of disease vectors and vermin, provision of health care facilities and adequate storage of food.</li> <li>&gt; Port health safety officer (under the Public Health Act) monitors and controls communicable disease vectors, safety issues and fire safety and equipment.</li> </ul>
Local	Ward Committees for environment and community; Ward Executive Officers, Ward Councillors	<ul style="list-style-type: none"> <li>&gt; Oversee general development plans for the Ward and implementation of legislative requirements at ward level</li> <li>&gt; Provide information on local situation extension services</li> <li>&gt; Provide technical support and advice to district and municipal offices</li> <li>&gt; Project Monitoring</li> </ul>
	Local NGOs (WWF, IUCN, WIOMSA)	<ul style="list-style-type: none"> <li>Programmes and studies for</li> <li>&gt; Conservation of coastal and marine resources</li> <li>&gt; Socio-economic development from the use of natural resources</li> <li>&gt; Monitoring coastal and marine environments</li> </ul>
	Statoil HSE-manager	<ul style="list-style-type: none"> <li>&gt; Project concept, EIA study, project implementation</li> <li>&gt; Day-to-day environmental management and monitoring</li> <li>&gt; Environmental Auditing</li> </ul>

## 5 EXISTING ENVIRONMENTAL AND SOCIOECONOMIC CONDITIONS

### 5.1 EIA Boundaries

The EIA will include potential impacts of the exploration drilling activities that may be caused by:

- › Activities within the Block 2 area;
- › Activities taking place from the entrance to Mtwara Port to Block 2 (i.e. mainly supply vessel traffic) and
- › Activities from Dar es Salaam airport to Block 2 (i.e. mainly helicopter traffic).

The potential impact area of these activities includes primary impact areas that may be directly impacted by the activities and secondary impact areas that may be indirectly affected.

#### 5.1.1 Primary impact areas

The primary impact area is assumed to be the area where direct impacts from the planned and future potential unplanned exploration drilling activities could occur. Direct impacts are defined as changes that are caused by activities related to the project which occur at the same time and place where the activities are carried out (or within the immediate vicinity of the activities).

Block2 subareas

The primary impact area of the impact assessment of further exploration drillings in the Block 2 area has been defined as the entire Block 2 area where drilling may take place and where each well has a very small footprint around the actual drilling location. Block 2 includes three subareas (Cf. Figure 3-2):

- › Sea Gap (where drilling has taken place);
- › West Side (where drilling has not be carried out so far) and

- › Davie Ridge (where drilling has not be carried out so far).

### 5.1.2 Secondary impact areas

The secondary impact areas are regarded as the areas where indirect impacts from the proposed drilling activities could be observed. Indirect impacts are those changes that are caused by project-related activities, but are felt later in time and outside the primary impact area.

Sources of impact in secondary impact areas

Potential impacts can occur, not only from the drilling activity itself (direct impacts), but from the support infrastructure and activities necessary for the drilling unit to operate, and/or as a result of accidental oil spills (indirect impacts). The support infrastructure includes supply vessels, shore based sources of supplies, waste disposal operations, storage areas, and helicopter operations.

Accidental spills of for example crude oil, gas, fuel oil or drilling chemicals during drilling operations have the potential to affect a much larger area than the immediate boundary of the primary impact areas (drilling sites in Block 2 and navigation routes) and impacts may occur at considerable distances from the location of the incident including sensitive coastal ecosystems, driven mainly by wind and surface currents. The prevailing ocean current in the area is the East African Coastal Current (or EACC). From the well locations the currents are likely to transport any floating material northwards, though these are short periodic seasonal reversals.

Location of secondary impact areas

The secondary impact area will therefore include:

- › The area of sea between the drilling locations and Mtwara Port where supply vessels will transport materials between the drill ship and Mtwara Port equivalent to a narrow band of about 100 km length;
- › The helicopter route from Dar es Salaam Airport to the well location which will cross Mafia Island;
- › The entire Tanzanian coastline and Islands but with emphasis on:
  - › The coastal stretch from the Mozambique border to Lindi including the Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP) which is within 10 km of the navigation route on the approaches to Mtwara Port;
  - › The Rufiji-Mafia-Kilwa Ramsar site;
  - › The Mafia Island Marine Park (MIMP) and
  - › The Songo Songo Archipelago

## 5.2 Environmental baseline

### 5.2.1 Physical features Tanzanian waters

#### 5.2.1.1. CLIMATE

Tanzania is situated in the tropical monsoon climate zone typical for the Western Indian Ocean region. Temperatures and humidity are high (20-35 °C and 60-80%, respectively). The climate is influenced by two main monsoon seasons, the north-east monsoon prevailing from November to March and the south-east monsoon from April to October. The monsoon causes quite distinct wet and dry seasons (Newell 1957, Iversen et al. 1984, McClanahan 1988).

#### 5.2.1.2. RAINFALL

The main rainy season is from March to May, while intermittent rains fall from November to December. In between are two dry seasons. Along the coast, rainfall ranges from 500 mm/year in Mtwara and Lindi, to over 750 mm/year in Mafia and northern Tanzania (Semesi and Ngoile 1995).

#### 5.2.1.3. WINDS

The surface winds are predominantly north-eastern during the austral summer (June-September) and south-eastern during the winter (November-March), mainly influenced by the migration of the ITCZ and the monsoon (Sumner, 1982). The southeast monsoon (Kusi) prevails from April to October with wind speeds of force 13-38 knots (34-70 km/hr.), with strongest winds from May to August, though wind directions are variable. Following a complete reversal of wind direction, the northeast monsoon (Kaskazi) prevails from November to March, with winds of 13-19 km/hr. (Africa Pilot, 2006). In a study by Dubi (2001) of coastal winds from 1986 to 1996, the highest wind speeds reached in Mtwara were 35 knots (64 km/hr.).

#### 5.2.1.4. CURRENTS

The Tanzanian waters are influenced by the north-going East African Coastal Current (EACC) throughout the year. EACC originates from the bifurcation of the Southern Equatorial Current (SEC) at approximately 10° S. During the south-east monsoon the EACC flows parallel to the shore reaching 2 m/s, whereas it flows obliquely towards the shore during the north-east monsoon (Newell 1959).

During the southeast monsoon season the flow of the EACC reaches 4-5 knots, or 7-10 km/hr. (Nhnyete and Mahongo, 2007); while during the northeast monsoon, the flow is reduced to 1 knot (approx. 2 km/hr.). Statoil's own Joint Industry Project (JIP) METOCEAN study conducted over twelve months (2009-2010), included measurements in Block 2 that confirmed the relatively strong ocean currents present during the south-east monsoon season.

#### 5.2.1.5. WAVES AND TIDES

Wave height is greatest during the SE monsoons from April to October (McClanahan 1988). With a few exceptions, the tidal range in east Africa,

including the Comoros islands and the west coast of Madagascar, is 2 – 4 m. The Tanzanian coast experiences mixed semidiurnal tides with a tidal range of about 3.6 m at spring tide and 1.1 m at neap tide (Semesi and Ngoile, 1995, Ngusaru 2002). Spring tides are largest during the new moon, and during the equinoxes (March and September).

## 5.2.2 Physical features in Block 2

### 5.2.2.1. BATHYMETRY

#### Block 2

Block 2 is situated beyond the continental shelf which extends to 200 m depth contour) but on the upper portion of the continental slope. The water depth in Block 2 ranges between 1700 and 3300 m (Figure 5-1). From Block 2 to Mtwara Port along the proposed navigation route, water depths are mainly between 1,000 to 2,600 m, becoming progressively shallower close to the entrance to Mikindani Bay/Mtwara Port.

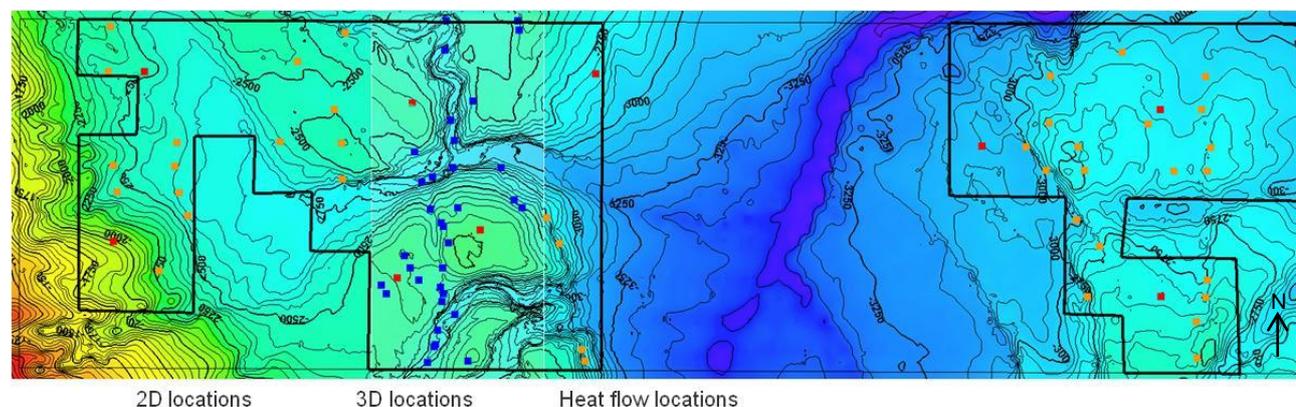


Figure 5-1 Depth contours in Block 2 area (Source: Statoil).

### 5.2.2.2. TEMPERATURE, SALINITY AND OXYGEN

#### Zafarani and Lavani

The SERPENT deep sea surveys carried out at Zafarani and Lavani in January 2012 and May/June 2012, respectively (Cf. below) (Serpent and Statoil 2012a, 2012b) showed that:

- › Water temperature decreased with depth from 28° C at the surface to 2.5 °C at the seabed;
- › Salinity was generally constant with depth and around 35 ‰. At the surface the salinity was slightly higher due to evaporation associated with high air temperature;
- › Oxygen concentration decreased with depth from around 200 µM at 500 m depth to around 50 µM at 1000 m depth and then gradually increasing to around 180 µM at the seabed. The increase is a result of the decreasing temperature (colder water can contain more oxygen than warmer water). The measurements are from Lavani. At Zafarani there are only data available from waters deeper than 1000 m;

- › Distribution of cuttings on the seabed indicated that currents at Zafarani were predominantly north flowing.

### 5.2.3 Biological features in Block 2

#### 5.2.3.1. SURFACE WATERS

##### Plankton

There is a summer bloom of phytoplankton in the Block 2 area caused by the upwelling of nutrients from the deep (Lèvy et al 2007). The phytoplankton forms the basis of production of zooplankton and pelagic fish species. The zooplankton is dominated by crustaceans (euphausiids and copepods) and chaetognats (Roger 1994).

##### Pelagic fish

Billfish and several species of tunas are commercially important pelagic fish species that are encountered in the area such as yellowfin tuna (*Tunnus albacores*) and skipjack tuna (*Katsuwonus pelamis*) which prey on small pelagic fishes that in turn are feeding on the plankton (IOC 2005, Pillay and Satheeshkumar 2012, Roger 1994).

During a survey at Zafarani, Dorado (Dolphinfish), small sharks, barracuda and indeterminate small yellow fin tuna (*Thunnus albacores*), were observed (Statoil and Serpent 2012a) (Figure 5-2).



Figure 5-2 Yellowfin tuna near the surface at the Zafarani site (Source: Statoil and Serpent 2012a)

##### Marine turtles

Marine turtles may be migrating or feeding in the Block 2 area. Breeding takes place on beaches on the mainland coast. The following species have been observed in Tanzanian waters: Loggerhead (*Caretta caretta*), Olive Ridley (*Lepidochelys olivacea*), Leatherback (*Dermodochelys coriacea*), Green (*Chelonia mydas*) and

Hawksbill (*Eretmochelys imbricate*). All are listed as Endangered or Critically Endangered on the IUCN Red List. Nesting takes place on beaches on the mainland coast of Temeke District, in nearby Mafia Island Marine Park and south at Mnazi Bay-Ruvuma Estuary Marine Park.

The coast of Kilwa and Lindi Districts are known for turtle nesting sites, which would result in a high concentration of marine turtles in the coastal and offshore waters, at least during the nesting season. However, largely due to their remoteness and inaccessibility, these sites have not been fully documented or monitored (Sea Sense pers. comm.).

#### Marine mammals

Whales and dolphins, which may be on passage, feeding, breeding or nursing young, may be encountered in Block 2. During seismic surveys carried out by Statoil in the three subareas of Block 2, West side, Sea Gap and Davies Ridge during the period 7/12 2012 - 22/1 2013, whales and dolphins were systematically observed by whale experts. The results are shown in Table 5-1.

Dolphins completely dominated the observations. Spinner Dolphin (*Stenella longirostris*) was the most abundant species, followed by Spotted Dolphin (*Stenella attenuate*) and Rissos Dolphin (*Grampus griseus*). Further, a few Indian Ocean Bottlenose Dolphin (*Tursiops aduncus*), Bottlenose Dolphin (*Tursiops truncatus*) and probably Frasers Dolphin (*Lagenodelphis hosie*) were encountered.

A group of 90 individuals of whales which probably were Melon-headed Whale (*Peponocephalus electra*) was observed on one occasion the Sea Gap area.

In addition a few of the following whale species where observed:

- › Humpback whale (*Megaptera novaeangliae*);
- › Sperm whale (*Physeter macrocephalus*);
- › Short-finned Pilot Whale (*Globicephala macrorhynchus*);
- › Possible False Killer Whale (*Pseudorca crassidens*) and
- › Probable Pygmy Killer Whale (*Feresa attenuata*)

These species are listed as vulnerable on the IUCN Red List (Berggren, 2009).

Humpback whales seasonally visit the warm waters off eastern Africa each year to give birth and for over-wintering, hence avoiding the cold Antarctic winter. Between end of June and December, hundreds or possibly thousands of whales are observed in the waters between Kenya and Mozambique, usually headed south as they return to their feeding grounds. Numerous observations of mothers with small calves have been recorded.

The Institute of Marine Sciences on Zanzibar (with Newcastle University's Dr Per Berggren) has compiled data on Humpback whales around the southern end of Unguja Island from 2006-2012, establishing a catalogue of 500+ photo-identified adults. The presence of newborn calves in the study area (2-5% in 2009-2012), as well as observations of competitive groups and recordings of singing males, indicate that the waters off Zanzibar is a breeding area for humpback whales in East Africa. However, the relatively low number of whales re-sighted within and between years further indicates that the area is likely part of a much larger breeding ground in East Africa (<http://www.ncl.ac.uk/marine/research/project/4576>).

The precise migration route of the seasonal visit of humpback whales to Tanzanian waters is not mapped but is likely to be related to the ocean currents and in particular the eddies and gyres associated with the coastline. At times, whales are seen within a few hundred metres of the coast, or several kilometres out to sea. Statoil's own marine mammal observer (MMO) programme (Statoil, 2013) for recent seismic surveys (October 2012 to February 2013) reported three sightings of five Humpback whales within Block 2, presumably headed south (date not given).

Table 5-1 Whales and dolphins observed during seismic surveys in the three subareas of Block 2 during the period 7/12 2012-22/1 2013. Number of observation days in each survey area is indicated.

Species	West Side Number of observation days: 20 Numbers observed	Sea Gap Number of observation days: 4 Numbers observed	Davies Ridge Number of observation days: 39 Numbers observed
Humpback Whale ( <i>Megaptera novaeangliae</i> )	-	-	3
Probably Humpback Whale	-	-	2
Baleen whale sp.	-	1	-
Sperm Whale ( <i>Physeter macrocephalus</i> )	1	2	9
Probably Sperm Whale	-	-	3
Short-finned Pilot Whale ( <i>Globicephala macrorhynchus</i> )	-	-	28
Possibly False Killer Whale ( <i>Pseudorca crassidens</i> )	6	-	-
Probably Pygmy Killer Whale ( <i>Feresa attenuata</i> )	-	-	3
Probably Melon-headed Whale ( <i>Peponocephalus electra</i> )	-	90	-
Spinner Dolphin ( <i>Stenella longirostris</i> )	96	55	1469
Probably Spinner Dolphin	20	-	91
Spotted Dolphin ( <i>Stenella attenuate</i> )	-	-	138
Indian Ocean Bottlenose Dolphin ( <i>Tursiops aduncus</i> )	14	-	-
Bottlenose Dolphin ( <i>Tursiops truncatus</i> )	1	-	6
Probably Bottlenose Dolphin	-	-	10
Rissos Dolphin ( <i>Grampus griseus</i> )	47	5	77
Probably Rissos Dolphin	-	-	6
Probably Frasers Dolphin ( <i>Lagenodelphis hosie</i> )	-	-	1
Unidentified Dolphin	143	12	261

### Seabirds

Few seabirds are likely to be seen in Block 2 but species like Masked Booby (*Sula dactylatra melanops*), Swift Tern *Sterna (Bergii thalassina)* and Common Noddy (*Anous stolidus plumbeigularis*) that may feed far offshore may be encountered. These species roost and nest on offshore islands such as Latham Island north of Mafia Island or islands to the south in Mozambique but have their feeding areas great distances from shore.

#### 5.2.3.2. THE SEABED

The seabed environment in Block 2 with water depths mainly ranging between 2300 and 2600 m is typical of deepwater ecosystems around the world - completely dark and very cold, about 5° C.

#### Existing studies

##### SERPENT Project

As part of the SERPENT project sediment characteristics and deep-sea benthic fauna was studied in connection with the exploration drilling at Zafarani-1 and Lavani-1 in the Sea Gap area. The SERPENT project (*Scientific and Environmental ROV Partnership using Existing Industrial Technology*) is a collaborative project between world leading scientific institution and companies associated with the oil and gas industry. The objectives of the project are to study deep sea fauna and impact on the seabed of deep sea drilling operations. SERPENT is hosted at the National Oceanography Centre Southampton. Statoil is a main participant in this project.

##### SERPENT studies at Zafarani and Lavani

The two studies carried out at Statoil Tanzania's Zafarani-1 and Lavani-1 was carried out from the drill ship "Ocean Rig Poseidon" during drilling operations. The ship's Remote Operated Vehicle (ROV) (Figure 3-6) and high definition video cameras were used to survey the seabed. The following observations were made:

- › Abundance and diversity of sea bed megafauna. Megafauna include invertebrates and fish typically larger than 1-5 cm and therefore visible on the video camera;
- › The extent of seabed covered by cuttings (disturbance analysis).

The ROV equipment also collected sediment samples for chemical analysis.

##### Remote operated Vehicle (ROV)

The ROV is operated from the drill ship and is part of the drill ship's equipment for monitoring drilling operations, but can also be used for environmental studies. The ROV is equipped with video-cameras, spotlights, and multifunctional arms that may collect sediment cores, pick animals from the seabed or place and later retrieve sampling equipment on the seabed. Examples of environmental monitoring and studies that can be conducted with ROV are:

- › Visual survey of the seabed which may include observing changes in sediment surface due to sedimentation of cuttings, and observations of meiofauna;
- › Collection of short sediment cores for sampling of meio- and macrofauna and chemical and physical characterization of surface sediments;

- › Placement and monitoring of baited traps or light traps on the seabed in order to attract and sample animals;
- › Bioturbation experiments;
- › Placement of markers at various distances from the well-head to monitor the accumulation of drill cuttings

#### Core sampling of benthic fauna in Block 2

In addition, as a part of a geochemistry survey, Statoil has collected a total of 130 core samples of benthic infauna from the entire Block 2 area.

The samples were collected by the MV Ryan T and preserved in buffered Rose Bengal stained formalin and brought to Kuduchi Research Station where infauna was analysed. In the laboratory the samples were treated as follows:

- › Separating the fauna from sediment;
- › Separating macrofauna from meiofauna and
- › Identifying and counting macrofauna and meiofauna

In addition grain size and organic matter content of sediment analysis is ongoing.

The results have been reported in an Interim Report (Ndaro et al 2012). The full report has not been published yet.

Both the results of the SERPENT-surveys and the core sampling of the benthic fauna have been presented in a seminar arranged by Statoil in Dar es Salaam in January 2013.

#### Sediment composition

The seabed sediment in the area is soft bottom consisting of fine grained deep-sea ooze, i.e. sediment of which at least 30 % is composed of the skeletal remains of microscopic pelagic organisms that have sunken and settled on the seabed after death. The ooze in the Block 2 area is calcareous ooze primarily consisting of exoskeletons of coccolithopores which are a group of plant plankton species. Hard substrate was not observed in the area. (Serpent and Statoil 2012a and 2012b).

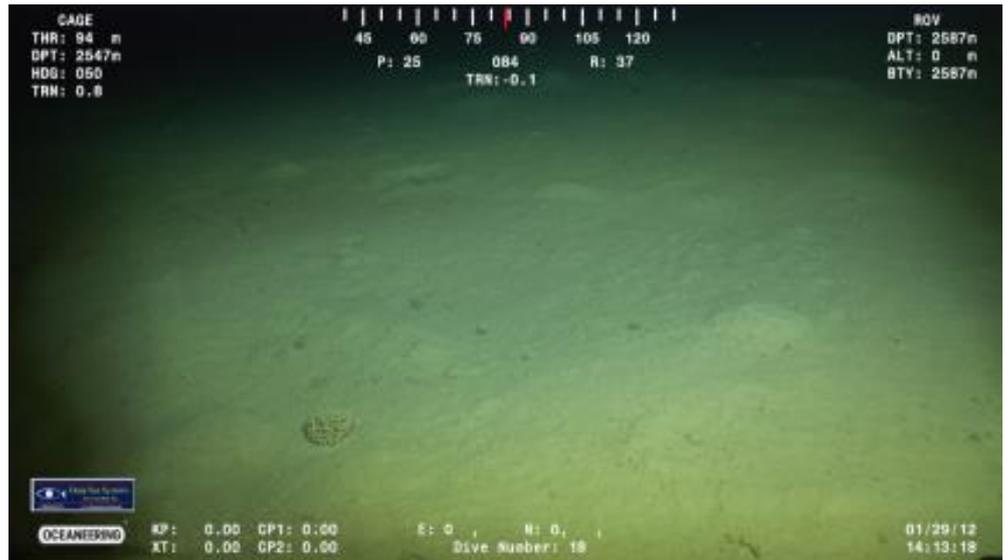


Figure 5-3 Image of seabed at Lavani-1 (Source: Serpent and Statoil 2012b).

Living conditions for benthic fauna in deep waters

#### Benthic invertebrate fauna

There is no visible light at depths below 200 m and below 1000 m depth all traces of light are absorbed. Consequently, no photosynthesis takes place on the seabed in Block 2 (where the depth is generally more than 2000 m). The deep ocean floor is therefore food limited and the only input of food and energy for the deep sea organisms is dead phytoplankton and their consumers from the surface waters resulting in relatively low abundance of deep sea organisms compared to shallower waters (Figure 5-4). However, it has been observed that the diversity of life in the deep sea can be extremely high.

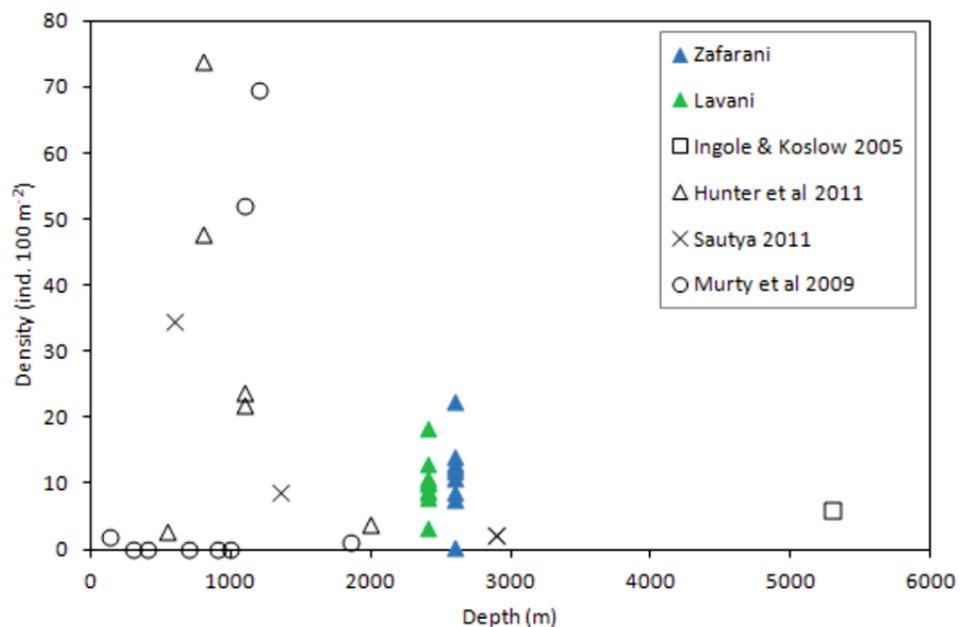


Figure 5-4. Density of benthic megafauna organisms with increasing depth in Indian Ocean studies carried out using video and photographic survey methods; Zafarani and Lavani data points are shown in colour (For Zafarani and Lavani each point represents one complete video-transect (Source: Serpent and Statoil 2012b).

## Groups of benthic fauna

The seabed houses a variety of benthic invertebrate species that can be grouped as:

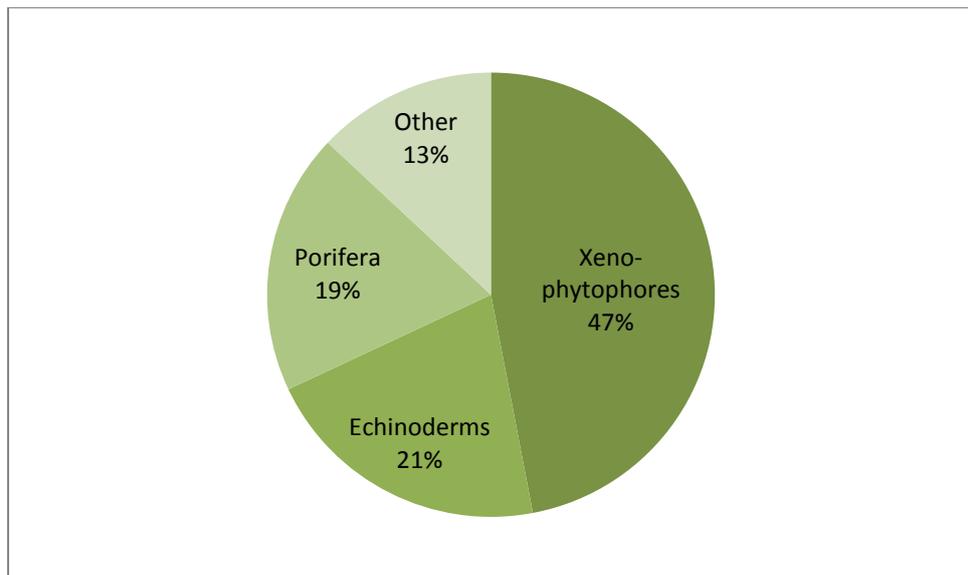
- › Epibenthic fauna which consist of species living on the surface of sediment and
- › Infauna, consisting of species that are living buried in the sediment.

The benthic fauna can also be grouped as:

- › Megafauna (= organisms larger than 1-5 cm and visible on cameras),
- › Macrofauna (= organisms that can be retained on a sieve of a mesh size > 1mm, but smaller than 1 cm) and
- › Meiofauna (= organisms that can be retained on a sieve of a mesh size < 63 µm).

## Composition of mega fauna at Lavani and Zafarani

A total of 32 different taxa of epibenthic invertebrate megafauna were observed at Zafarani. At Lavani 35 different taxa were encountered. The fauna was dominated by xenophytophores, echinoderms and sponges (Porifera) (Figure 5-5).



*Figure 5-5 Composition of the epibenthic invertebrate megafauna at Zafarani. Percentage of number of species in different major groups of fauna of the total number observed. (Source Serpent and Statoil 2012b)*

Xenophytophores are small single-celled protozoan organisms (Figure 5-6). The visible part is agglutinated matter that they secrete. They are very fragile and are exclusively found in deep water.

The Porifera particularly included glass sponges and the Echinoderms were mainly holothurians (Figure 5-6). The holothurians move around slowly and feed on organic matter in the sediment that has settled down from the surface waters.

Brittle stars were also common (Figure 5-6). These species move their flexible arms, disturbing the sediment in the process and thus causes bioturbation of the sediment.

Cnidaria (jelly fish, coral and sea anemones), molluscs (snails and bivalves) and crustaceans were observed, but they were not common.

The epibenthic invertebrate megafauna play an important role in the benthic systems, contributing significantly to benthic biomass, organic matter recycling and total benthic energy turnover. The megafauna is important in dispersing and redistributing organic matter and sediment and may be important in the recovery of deep sea benthic ecosystems from disturbance (Serpent and Statoil 2012a).

#### Composition of macrofauna in Block 2

The abundance of macrofauna in the sediment samples from Block 2 was rather low and included nematode worms, snails, foraminiferans, ostracods, polychaetes, cnidarians, sponges, bivalves, crustaceans and holothurians (Ndaro et al 2012).

The meiofauna in Block 2 is dominated by foraminiferans and nematodes. The meiofauna decompose and remineralise organic matter and is a source of food to many marine organisms (Ndaro et al 2012).



Xenophytophore



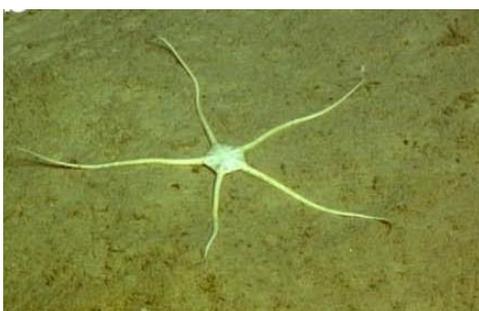
*Umbellula* sp. (Sea Anemone)



An echinothuriid sea urchin (Echinoderm)



Holothurian (Echinoderm)



A Brittle star (ophiurid)



A Crustacean (possible *Sergestes* or *Solenosera*)

Figure 5-6 Examples of epibenthic invertebrate mega fauna species that were observed at Zafarani-1 and Lavani-1 during the SERPENT survey. (Source: Serpent and Statoil 2012 a and 2012b)

Water depth and sediment composition are important parameters that influences the composition of the benthic fauna.

Composition of benthic fauna in Block 2

Zafarani and Lavani are situated in the Sea Gap area of Block 2 with a depth range of 2500-3000 m. As the depth ranges and sediment composition in the West Side (1750-2500 m) and Davie Ridge (2500-3300 m) are quite similar to the Sea Gap area and deeper than 1000 m, below which the density of organisms are on the same low level (Cf. Figure 5-4), it is reasonable to assume, that the composition of benthic fauna is largely similar to Zafarani and Lavani in the entire Block 2 area. Minor variations may be observed though, as a comparison with the Zafarani and Lavani results show (Serpent and Statoil 2012a and 2012b).

Benthic fish

A total of 10 different species of benthic fish were observed at Zafarani and Lavani including (Serpent and Statoil 2012a, 2012b):

- › Richardsons Ray (*Bathyraja richardsoni*) (Cf. Figure 5-7);
- › Coryphaenoides-like macrourid;
- › Blue antimora (*Antimora rostrata*) (Cf. Figure 5-7);
- › An ophioidid (brotulid) probably of genus *Porogadus* or *Penopus*;
- › Bony-eared assfish (*Acanthonus armatus*) (Cf. Figure 5-7);
- › Ophioidid either *Bassogigas* sp or *Cataetyx* sp.;
- › Deep-sea lizardfish (*Bathysaurus ferox* );
- › Unidentified ophioidid, aphynoid of liparid;
- › Ipnops sp. and
- › *Bassozetus* sp. (Cf. Figure 5-7)

Distribution and biology of selected species

Richardsons Ray (*Bathyraja richardsoni*) is found in deep water between 48°N and 42°S on lower parts of continental slopes, on submarine rises and on deep-sea plains adjacent to both. Feeds mainly on fishes and to some extent also shrimps. It is oviparous with eggs having horn-like projections on the shell (Fishbase 2013).

Blue antimora (*Antimora rostrata*) is found on deep water in the depth range 350 - 3000 m, usually on 1300 - 2500 m between 62°N - 62°S. May move offshore with age and spawn in the deeper parts of its range. Feed on benthic invertebrates (Fishbase 2013).

Boney-eared assfish (*Acanthonus armatus*) is a common species in deep waters off tropical and subtropical areas of all oceans. It is oviparous, with oval pelagic eggs floating in a gelatinous mass (Fishbase 2013).

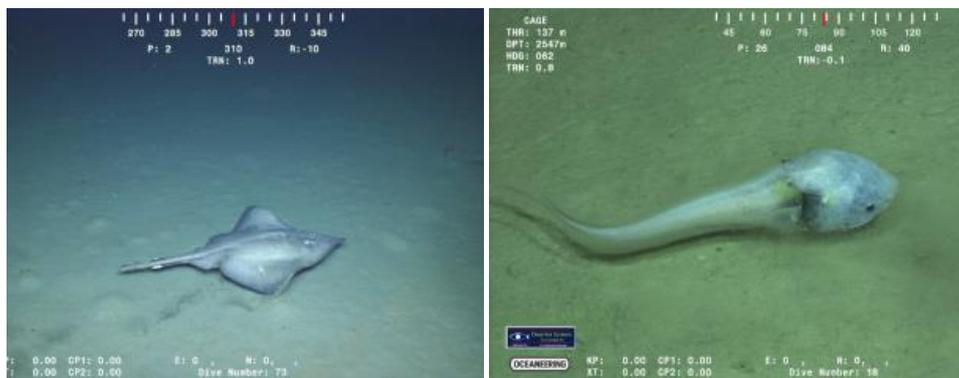
Deep-sea lizardfish (*Bathysaurus ferox*) is encountered in the depth range 600 - 3500 m, usually at 1000 - 2500 m. Occurs usually below the 4°C isotherm. Rests stationary on the bottom with head slightly elevated in typical lizardfish fashion. It feeds primarily on fish and decapods and is synchronously hermaphroditic (Fishbase 2013).

The fish fauna in the entire Block 2 area is expected to be similar to the fish fauna observed at Zafarani and Lavani as the depth range in Block 2 (1700-3300 m) is within the range in which the species encountered at Zafarani and Lavani are distributed (350-3000 m for the species described above).



Blue antimora  
(*Antimora rostrata*)

*Bassosetus* sp.



Richardson's Ray  
(*Bathyraja richardsoni*)

Bony-eared assfish  
(*Acanthonus armatus*)



Coryphaenoides-like macrourid

*Iponops* sp.

Figure 5-7 Examples of benthic fish species that were observed at Lavani-1 during the SERPENT survey. (Source: Serpent and Statoil 2012b).

The majority of deep sea benthic fish species feed on small benthic fish and crustaceans and other benthic organisms.

### 5.2.4 Coastal Biological features

The following sensitive coastal biological features are encountered along the Tanzanian Coast (Muhando and Rumisha 2008):

- › Coral reefs;
- › Mangrove forests dominated by *Avicennia marina*, *Rhizophora mucronata* and *Cerios tagal*;
- › Seagrass beds;
- › Bays and estuaries such as Mnazi Bay, which is and Important Bird area (IBA 28) and Ruvuma estuary which is an important habitat for birds, mammals and fish;
- › Coelacanth catch sites;
- › Dolphin sites and
- › Protected areas including:
  - › The Rufiji-Mafia-Kilwa Ramsar Site;
  - › Mafia Island Protected Marine Park and
  - › Mnazi Bay Ruvuma Estuary Marine Park

#### 5.2.4.1. MANGROVES

Distribution of mangroves along the Tanzanian coast

Mangroves are various types of trees up to medium height and shrubs that grow and form swamp ecosystems in saline coastal sediments along tropical and subtropical coastlines, usually in sheltered bays and around river mouths. Mangroves are widespread in Tanzania (Muhando and Rumisha 2008). The largest continuous mangrove areas are found in Tanga district in the north, the delta of the Rufiji River, in Kilwa and Lindi districts, Muheza Bagamoyo, Kisarawe and in Mtwara, where the Ruvuma River forms an estuary close to the Mozambique border in the south (Figure 5-9) (Francis et al.2001). Of the total mangrove area of ~ 110,000 ha on mainland Tanzania, Mtwara mangrove forest covers~ 10,000 ha, Lindi ~4000 ha, Kilwa ~22,000 ha while mangroves in the Rufiji delta cover an area of 54,500 ha (Wang et al. 2001). All these mangrove forests are protected as coastal Forest Reserves (Muhando and Rumisha, 2008). Seven genera of mangroves occur in Tanzania, with *Rhizophora*, *Avicennia* and *Heritiera* being dominant.

Importance of mangroves

Mangrove forests are productive and very important ecosystems that provide habitat for a range of threatened or endangered species and are important feeding and nursery grounds for numerous ecologically and economically valuable fish, shellfish, prawn and crab species (Wang et al.2002). As the tide rises and submerges the mangrove flats, numerous fish move in to find food and shelter. In addition, mangroves prevent erosion in the estuarine system, form a protective barrier against winds and storms and reduce siltation on nearby reefs.

Mangrove forests also have substantial commercial value primarily in terms of timber produced but also products like gums, fibres and dyes.



Figure 5-8 Mangroves at Mtwara (Source: COWI)

#### 5.2.4.2. CORAL REEFS

Distribution of coral reefs along the coast of Tanzania

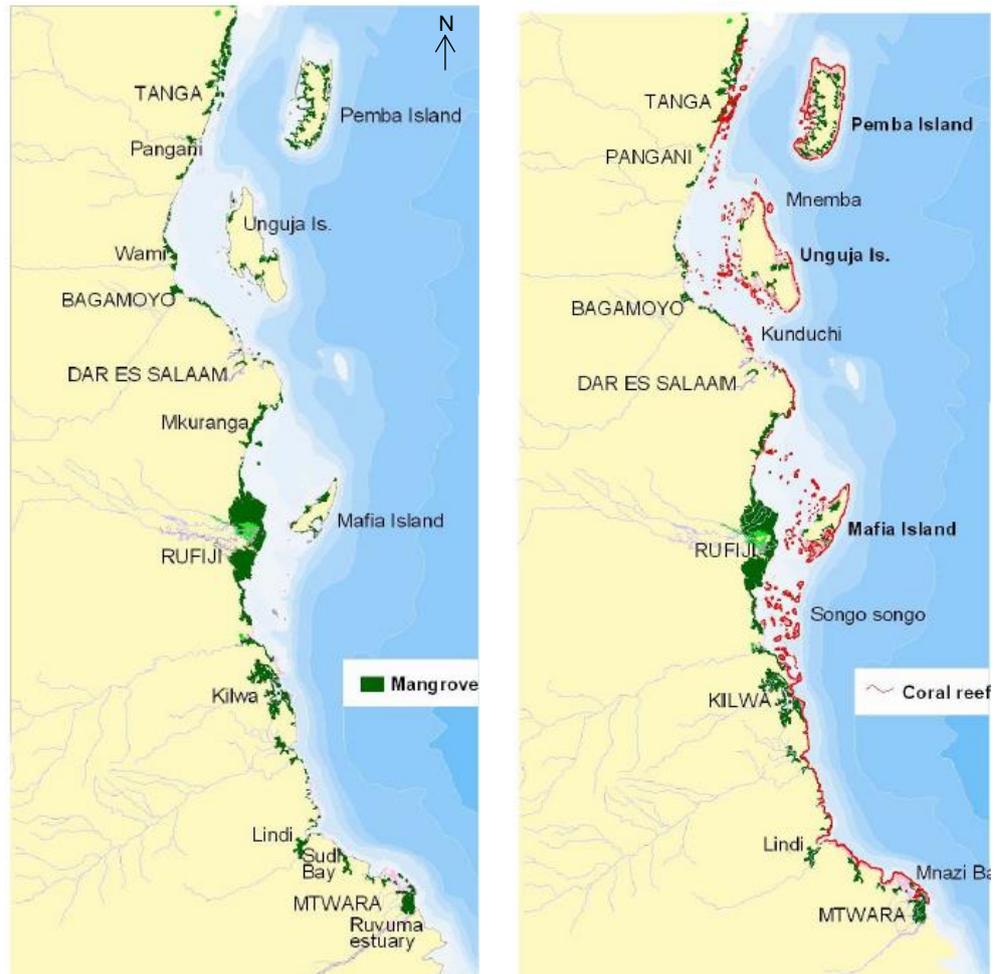
There are coral reefs along most of the Tanzanian coast (Figure 5-9). The reefs are fringing reefs, which form margins along the edge of the mainland and islands, and associated patch (Francis et al. 2001).

Biology and ecology of corals

Coral reefs are three-dimensional living structures comprised of corals (hard and soft), algae, sponges, molluscs and worms (Ngusaru 2002). The bulk of the reef is made up of hard corals, which have a calcareous skeleton and live in symbiosis with microalgae or zooxanthellae that give them their vibrant colours. Coral colonies grow very slowly. Besides providing fish, molluscs and crustaceans for the coastal population the coral reef protects coasts from storms, flooding, wave action and erosion, thus enabling the formation of seagrass and mangrove ecosystems. Coral reefs are also major tourist attractions. The coral reefs are very productive and vulnerable marine ecosystems (Hoegh-Guldberg 1999). When stressed, corals expel their zooxanthellae, thus losing colour hence the term ‘bleaching’. Bleached corals can recover, but typically die if conditions remain stressful e.g. if temperatures rise for prolonged periods. In 1997/1998 the El Nino Southern Oscillation (ENSO) raised seawater temperatures worldwide, resulting in up to 90% mortality in some places. Most reefs in Tanzania were affected. For example Kitutia reef in Mafia had 60 – 90% mortality, and four years later there was little or no improvement (Mohammed et al. 2002). Other effects of climate change have been the phase shift of coral reefs into algal dominated areas, epidemics of planktonic algae and disease, and increased occurrence of mantis shrimp and other invertebrates and fish swarms (Obura 2002).

A total of 258 species of corals have been recorded at Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP) and around 270 species at Mafia Island (Obura 2004).

However, destructive fishing methods (such as drag netting inside the park and dynamite fishing outside) pose a threat to the coral reefs in the area. Coral mining too, is an activity that has not entirely ceased.



Distribution of Mangroves along the Tanzanian coast

Distribution of Coral reefs along the Tanzanian coast

Figure 5-9 Distribution of mangroves and coral reefs along the coast of Tanzania (Source: Muhando and Rumisha 2008).

#### 5.2.4.3. SEAGRASS BEDS

Sea grasses are marine flowering plants, which occur in shallow waters and estuaries on sandy or muddy seabeds. They grow best in lagoons and protected areas on stable sandy substrates up to 25 m depth where sufficient light penetrate to facilitate photosynthesis. Seagrass beds are highly productive areas with a high species diversity and numbers of individuals (Semese et al., 1999). Seven different species of seagrass are encountered in Tanzanian waters.

Distribution of seagrass beds in Tanzania

Extensive sea grass beds are found in shallow (0-25 m) and sheltered areas of the coast around Mnazi Bay, Kilwa, Rufiji, Ruvu and Mwa. They also occur extensively on the western side of Pemba, Unguja and Mafia islands. Seagrasses

are stressed in areas with excessive sedimentation in some estuarine environments (Muhando and Rumisha 2008).

Ecological significance of seagrass beds

Seagrass beds are spawning, nursery and feeding areas for invertebrates and several species of fish and shellfish including commercially important species. They are also feeding grounds for Dugong, Green Turtle and Hawksbill Turtle.

#### 5.2.4.4. ESTUARIES

An estuary is a partially enclosed body of water formed where freshwater rivers, streams or groundwater flows to the sea and mix with the seawater and causing the accumulation of nutrient rich sediment that make estuaries very productive. They are therefore important areas for especially birds that may be found in numbers of thousands, but also invertebrates, fish and mammals. They serve as important nursery grounds for commercial fish and shellfish. The locations of estuaries in Tanzania are shown in Figure 5-10.

#### 5.2.4.5. IMPORTANT BIRD AREAS

Groups of birds

The Tanzanian coast houses a rich bird life. The coastal birds can be grouped in (Bennun et al. 2002):

- › Shoreline predators (such as birds of prey);
- › Wading birds (such as plovers and sandpipers) and
- › Genuine seabirds (such as gulls, terns, boobies and gannets)

Many of the bird species that are encountered along the coast are migratory. For example the Palaearctic migrant birds, that breed in the Arctic circle during summer and migrate to feeding grounds in East Africa during the winter on the Northern Hemisphere.

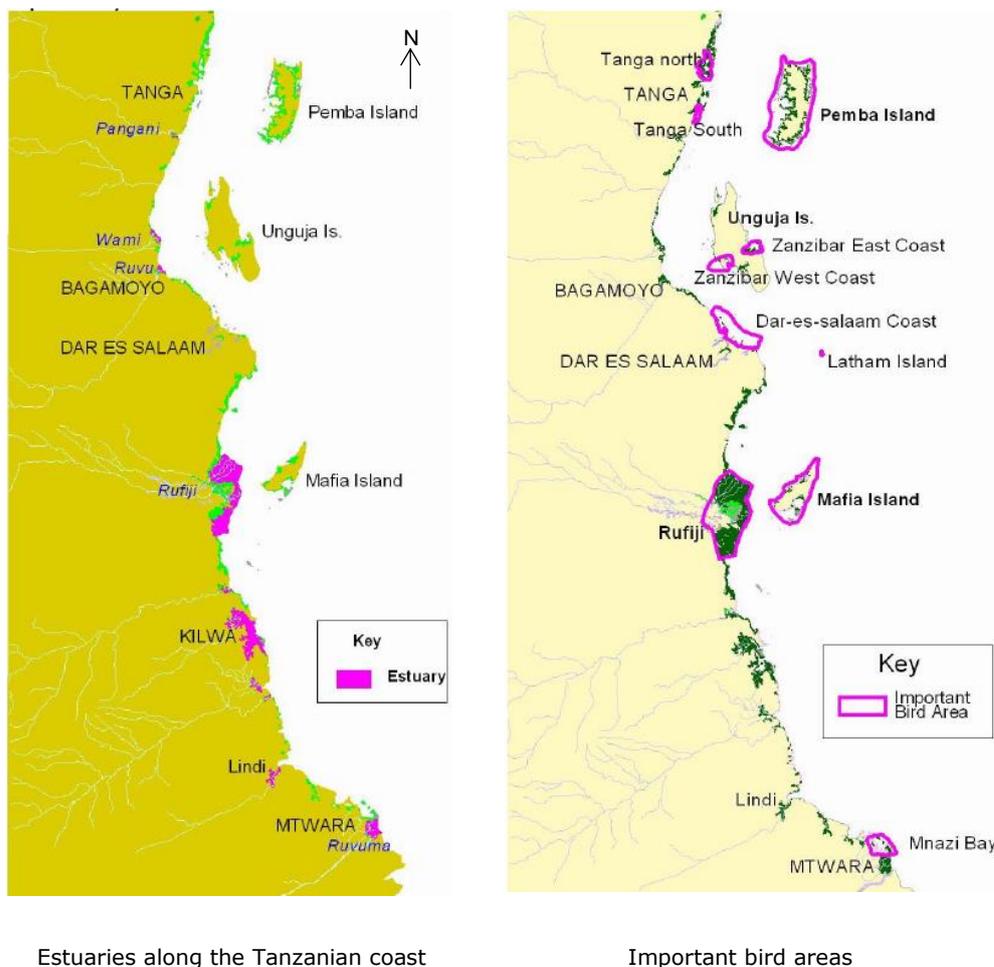


Figure 5-10 Distribution of estuaries and important bird areas along the coast of Tanzania (Source: Muhando and Rumisha 2008).

#### Designated IBAs

Birdlife International has designated the following areas along Tanzania's coast as Important Bird Areas (IBAs) along the coast (Baker and Baker, 2002) (Cf. Figure 5-10):

- Tanga North (IBA 35) – Kibo salt pans, south-west of Moa village; important populations of greater sandpipers and curlew sandpipers are encountered;
- Tanga South (IBA 36) – south of Mtangata Bay; salt pans, beach and mangroves. Important for greater sandpipers and crab plovers;
- Dar es Salaam (IBA 21) – intertidal mud flat (up to 25 sq km in area), with salt pans, mangroves, river inlets and small islets; tidal range of up to 4m. Important for crab plovers, roseate terns, saunders terns and numerous migrants in the northern winter;
- Rufiji Delta (IBA 32) - recognized locally and internationally as an important wintering ground for migrant birds and likely to be important for numerous wetland and water birds, but poorly known;

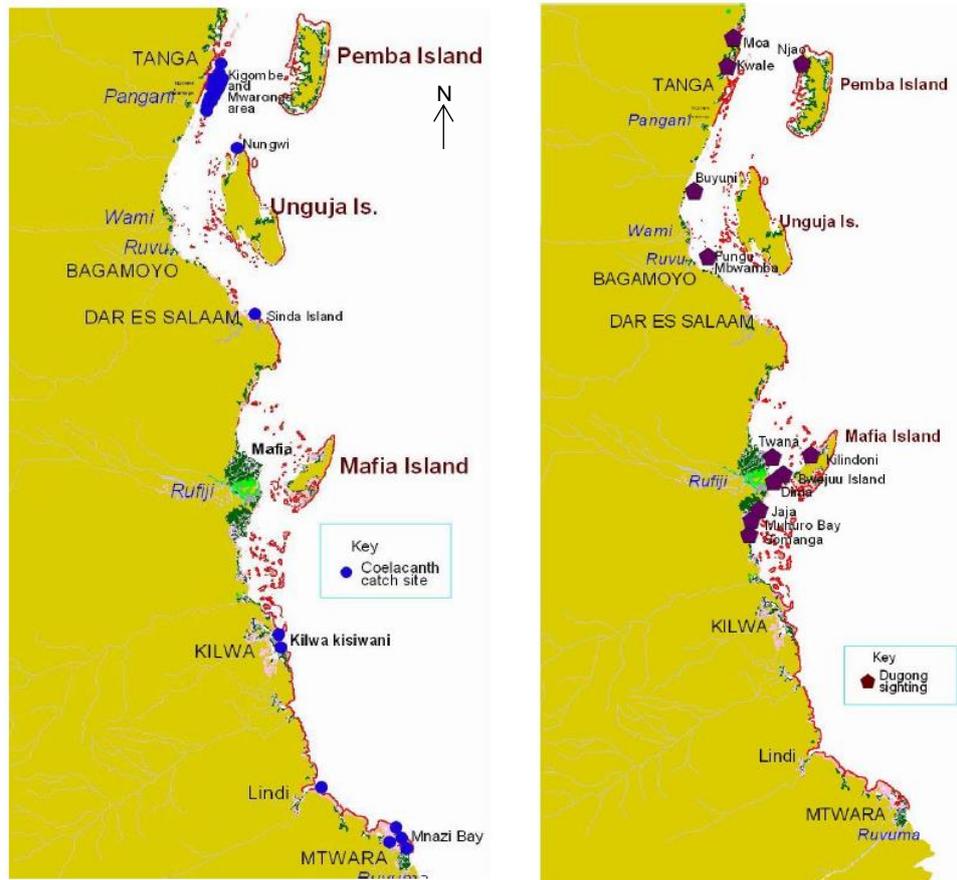
- › Mafia Island (IBA 12) provides staging ground for various Palaearctic migrant species. Mafia Island Marine Park in particular provides feeding grounds for a variety of wading birds. It also act as nesting areas for open-billed storks (*Anastomus lamelligerus*) and fish eagles (*Haliaeetus vocifer*) (Board of Trustees, 2000);
- › Mnazi Bay (IBA 28) – important area for migratory birds with salt pans and mangroves on small islands that provide major wader roosts;
- › Zanzibar South Coast (IBA 44) – important roseate tern colony on small islet off Chumbe Island; crab plovers and terek sandpipers and other waders in Kiwani and Kombeni Bays;
- › Zanzibar East Coast (IBA 45) – Chwaka Bay is a key area for crab plovers and greater sandpipers; up to 15% of the world population of saunder’s tern may winter here;
- › Pemba (IBA 76) – mainly important for endemic terrestrial species but large numbers of egrets and crab plovers observed and the mangroves may provide important bird roost and feeding grounds and
- › Latham I. (IBA 27) - critically important for its masked booby colony, and also an important breeding site for sooty terns, brown noddies, swift terns, and black-naped terns; considered the most important seabird island off the coast of East Africa. (Crawford et al. 2006). Also found on the island are several species of sandpipers, which are Palaearctic migrants.

#### 5.2.4.6.COELACANTH CATCH SITES

Of special mention is the Coelacanth (*Latimeria chalumnae*). This species was thought to have become extinct some 65 million years ago, but in 1938 it was sensationally caught in South African waters. Since then many other specimens have been caught elsewhere especially in the Comoros (1952), Mozambique (1991), Madagascar (1994), again in South Africa (2000), (Kenya 2001) and most recently in Tanzania, (2003) where the recurrence of the catches have raised fears that, the stocks of the fish might be depleted. It is listed as "*Critically endangered*" on the IUCN Red List. The coelacanth lives in deep ocean waters between 150 and 700 m depth. They prefer areas where there are submarine caves, canyons or deep reefs. To this date a total of 35 specimens have been caught in Tanzanian waters (Muhando and Rumisha 2008).The catch sites are shown in Figure 5-11.

#### 5.2.4.7. DUGONG SITING SITES

The Dugong is found in shallow waters and grazes on sea grasses. At one time considered locally extinct in Tanzania (Francis and Bryceson 2000). Now they are very rare, with only a few sightings particularly in the Rufiji-Mafia-Kilwa area, around Muheza, Zanzibar and probably in Mnazi Bay (Muir et al., 2003, Wells et al 2005, Muir 2006). Siting sites for Dugongs in Tanzania are shown in Figure 5-11. It is listed on the IUCN Red List as "*Vulnerable*". Is thought that they presently only are found in the Rufiji delta and maybe in Moa Bay, north of Tanga (Guissamulo 2002, Muir 2004).



Coelacanth catch sites along the Tanzanian coast

Dugong sighting sites along the Tanzanian coast

Figure 5-11 Coelacanth catch sites and Dugong sighting sites along the coast of Tanzania (Source: Muhando and Rumisha 2008).

#### 5.2.4.8. FEEDING AND NESTING SITES FOR MARINE TURTLES

Of the five species of marine turtles found in Tanzania, the most common and widespread is the Green turtle (*Chelonia mydas*). Nesting, which takes place on beaches, has been reported along the mainland coast from Tanga in the north to Mtwara in the south. However the most concentrated numbers of nests appear to be on the offshore islands of Zanzibar, Mafia and possibly the Songo Songo Archipelago with the main nesting season being between February and July (Muir 2004, 2005).

The coast of Kilwa and Lindi Districts are known for turtle nesting sites, however largely due to their remoteness and inaccessibility, these coastal nesting sites have not been fully documented or monitored.

#### 5.2.4.9. ENVIRONMENT AT MIKINDANI BAY AND MTWARA PORT

A coral reef system runs along both shores from Mtwara Port. To the west and north, interrupted by two passages (a small shallow mangrove creek north of Mtwara town) and into Mikindani Inner Bay, the fringing reef is separated by a

shallow lagoon. To the east (and south) a reef extends along Msamgamkuu Peninsula and then into MBREMP.

#### 5.2.4.10. PROTECTED AREAS

There are seven national marine protected areas (MPAs) along the mainland Tanzania coast, plus an additional five MPAs under the jurisdiction of the Zanzibar Government. The mainland Tanzania MPAs are:

- › Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP), south of Mtwara, to the border with Mozambique;
- › Mafia Island Marine Park (MIMP), comprising the southern portion of Mafia Island and smaller islands and reefs in/close to the Mafia Channel;
- › Nyororo, Shungumbili and Mbarakuni Islands Marine Reserve (in the northern Mafia Channel);
- › South Dar es Salaam Marine Reserve (Sida Island and surroundings);
- › North Dar es Salaam Marine Reserve (Bongoyo, Pangavini and Mbudya Islands and reefs);
- › Maziwe Island Marine Reserve, near Pangani and
- › Tanga Coelecanth Marine Park, off the coast of Tanga in northern Tanzania

The principal MPAs along the mainland coast are described below, commencing with the internationally-recognised Ramsar site that includes the MIMP.

#### The Rufiji-Mafia-Kilwa Ramsar Site

The Rufiji-Mafia-Kilwa area is a Wetland of International Importance under the international Ramsar Convention. The Ramsar site covers the delta of the Rufiji River; the Mafia Island about 25 kilometres offshore and surrounding smaller islands, sandbars, and coral reefs; the Songo-Songo Archipelago to the south and adjacent waters, including the Mafia Channel and waters between Mafia and Songo-Songo (Figure 5-12). About a tenth of the area of the Ramsar site is covered with mangrove forests. The Rufiji Delta mangroves shelter migratory wetland birds such as curlew sandpipers, crab plovers, roseate terns and Caspian terns. Nile crocodiles share the Rufiji Delta with hippopotamus, otters, and Sykes monkeys. The site covers extensive intertidal flats, seagrass beds, and sandbars, all ecologically interlinked with the flow of the Rufiji River. Yellowfin, wahoo, kingfish, dorado, and red cod swim these waters. Five species of globally threatened marine turtles have been recorded, including green and hawksbill turtles, as well as a small population of endangered Dugongs.

#### Mafia Island Protected Marine Park

The southern portion of the archipelago of Mafia was designated as the Mafia Island Marine Park (MIMP) in 1995 (Figure 5-13). The park is an important tourist site, due to its pristine marine life and the presence of a population of whale sharks.

The whale sharks aggregate near Kilindoni, Mafia during the months of October to April. The whale shark is listed as "*Vulnerable*" on the IUCN Red list and is on the Appendix II list of CITES. It is thought that the whale sharks may be partially resident, but some are also migrants as one individual tagged in Kenya was identified in 2007 -2008 (Potenski 2008)

Mafia Island is an important nesting site for turtles. It is also inhabited by several bat species including the rare Comoros Flying-Fox (*Pteropus comorensis*) (e.g. Cheke 2011), the recently reported *Hipposideros caffer* and *Nycteris thebaica* (Stanley 2008).

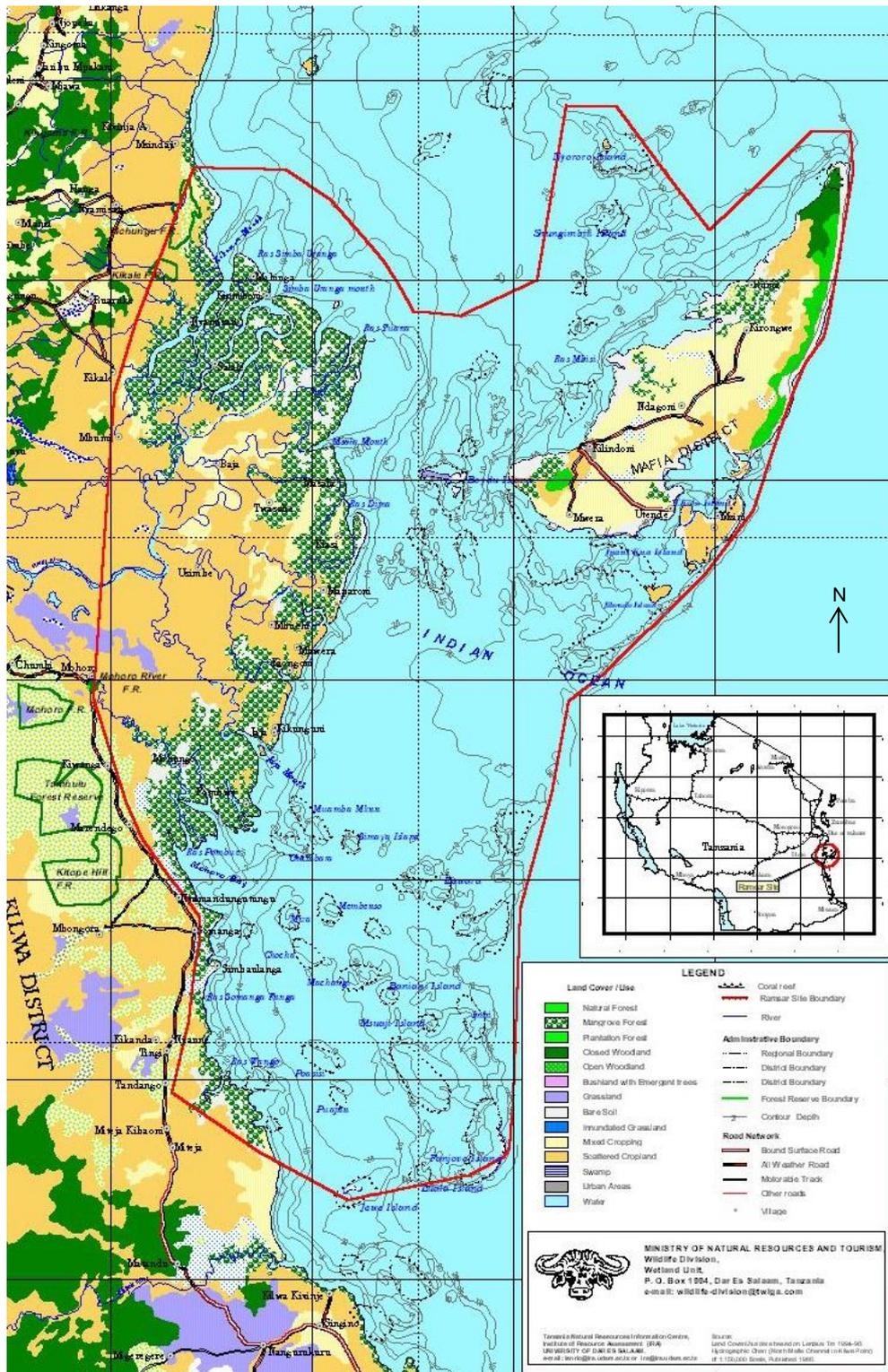


Figure 5-12 The Rufiji-Mafia-Kilwa Ramsar Site.(Source: Statoil 2011a)



Figure 5-13 Mafia Island Marine Park.(Source: Tanzania Marine Parks & Reserves 2002)

Mnazi Bay - Ruvuma Estuary Marine Park

Mnazi Bay Ruvuma Estuary Marine Park (MBREMP) was gazetted in 2000. (Figure 5-14). The park is a unique ecological system, important to the local economy and designated (together with Quirimbas Archipelago in northern Mozambique) as of Global Importance under the WWF Eastern Africa Marine Ecoregion programme. The MBREMP is also part of the proposed Transfrontier Marine Conservation Area, or “Peace Park”.



Figure 5-14 Mnazi Bay Ruvuma Estuary Marine park (MBREMP) (Source: Statoil 2011b)

### Tanga Coelacanth Marine Park (TACMP)

Tanga Coelacanth Marine Park (TACMP) is located on the northern coastline of Tanzania. It includes the bays of Tanga City and Mwambani, Tongoni estuary, and three small islands of Toten, Yambe and Karange. The uniqueness of the park includes: the occurrence and high rates of incidental catches of the CITES - listed and iconic Coelacanth, *Latimeria chalumnae*. The unprecedented catch incidents of coelacanths in Tanga area called for urgent management measures to protect the species in Tanzania, through protecting the reef and deepwater ecosystems where

these fishes live; hence the establishment of TACMP. The benefits of including this area in MPA will be more emphasis on the conservation of biodiversity especially protecting the critically endangered ‘once believed extinct’ fish, the coelacanth, *Latimeria chalumnae*.

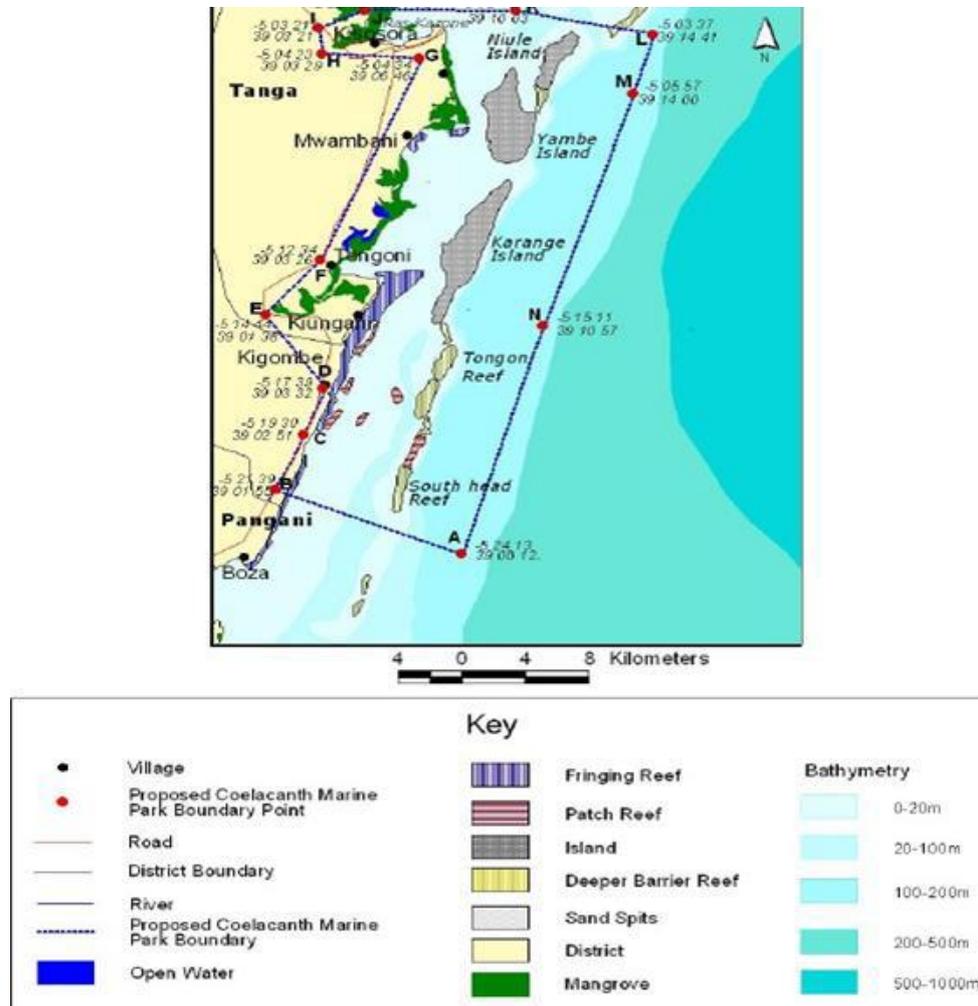


Figure 5-15. Tanga Coelacanth Marine Park (TACMP) (Source: Statoil 2011b)

### 5.2.5 Sensitivity ranking of the Tanzanian coastline (Environment)

As a preliminary requirement to the development of an oil spill contingency plan, Statoil commissioned a GIS-based sensitivity map for the coast of Tanzania (TanSEA). A total of 37 1:50.0000 maps were produced. The maps which combine more than 60 layers of data and a combined sensitivity map rank the coastline in terms of environmental sensitivity to oil (Samaki - ESI - Statoil (2011)). An example is shown in Figure 5-16.

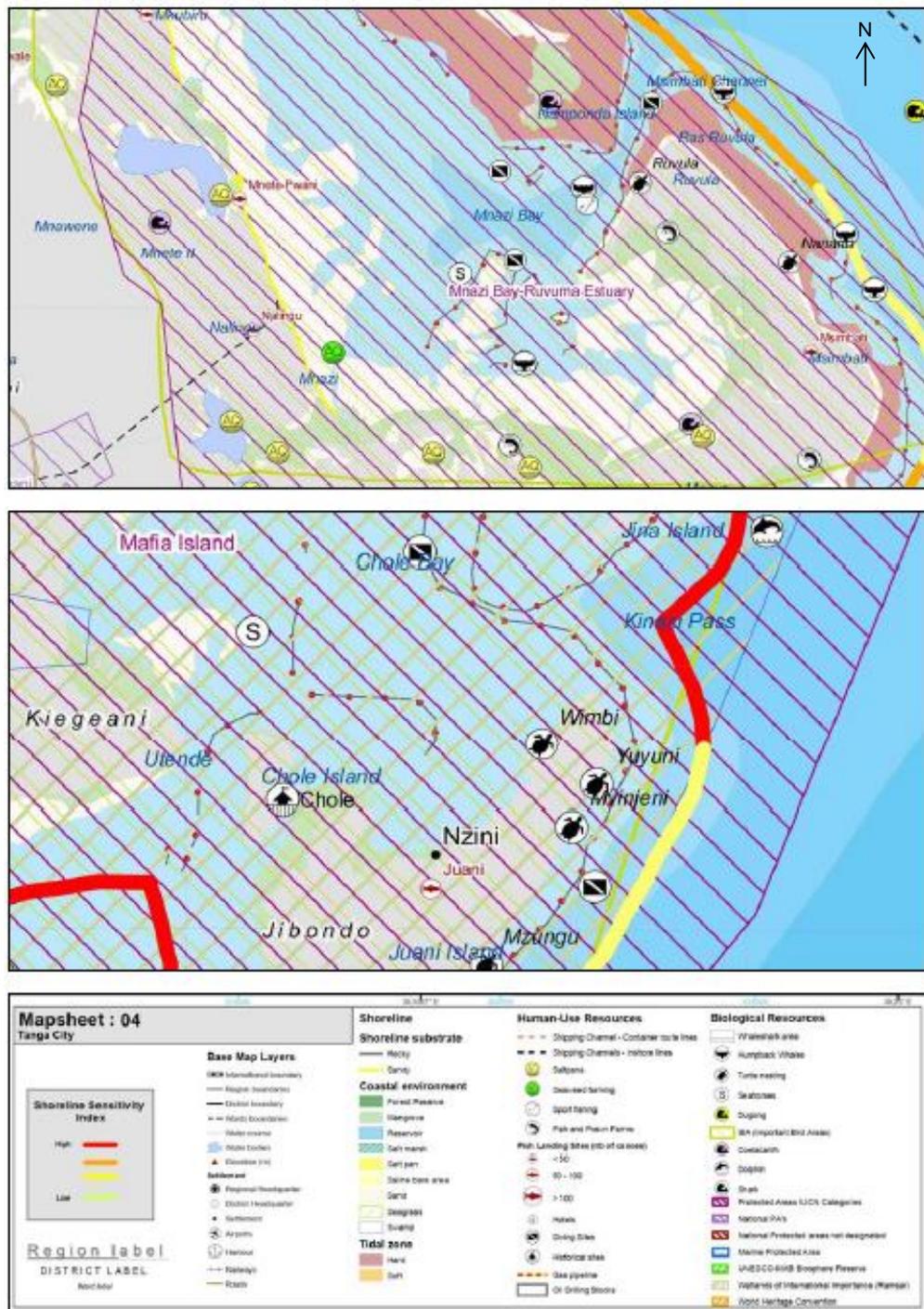


Figure 5-16. Sample details of 1:50,000 coastal sensitivity maps produced by Statoil. Portion of MBREMP (top), of MIMP (centre) and sensitivity map legend (bottom) (Source: TanSEA 2011).

A map ranking the sensitivities along the entire Tanzanian coast were also produced (Figure 5-17). The study confirmed the highly sensitive nature of much of the coastline of Tanzania that might be impacted by a major oil spill. The most sensitive areas are:

- › Mnazi Bay-Ruvuma Estuary;

- > Mafia Island/ Rufiji estuary /Songo songo archipelago;
- > Unguja Island and
- > Pemba island

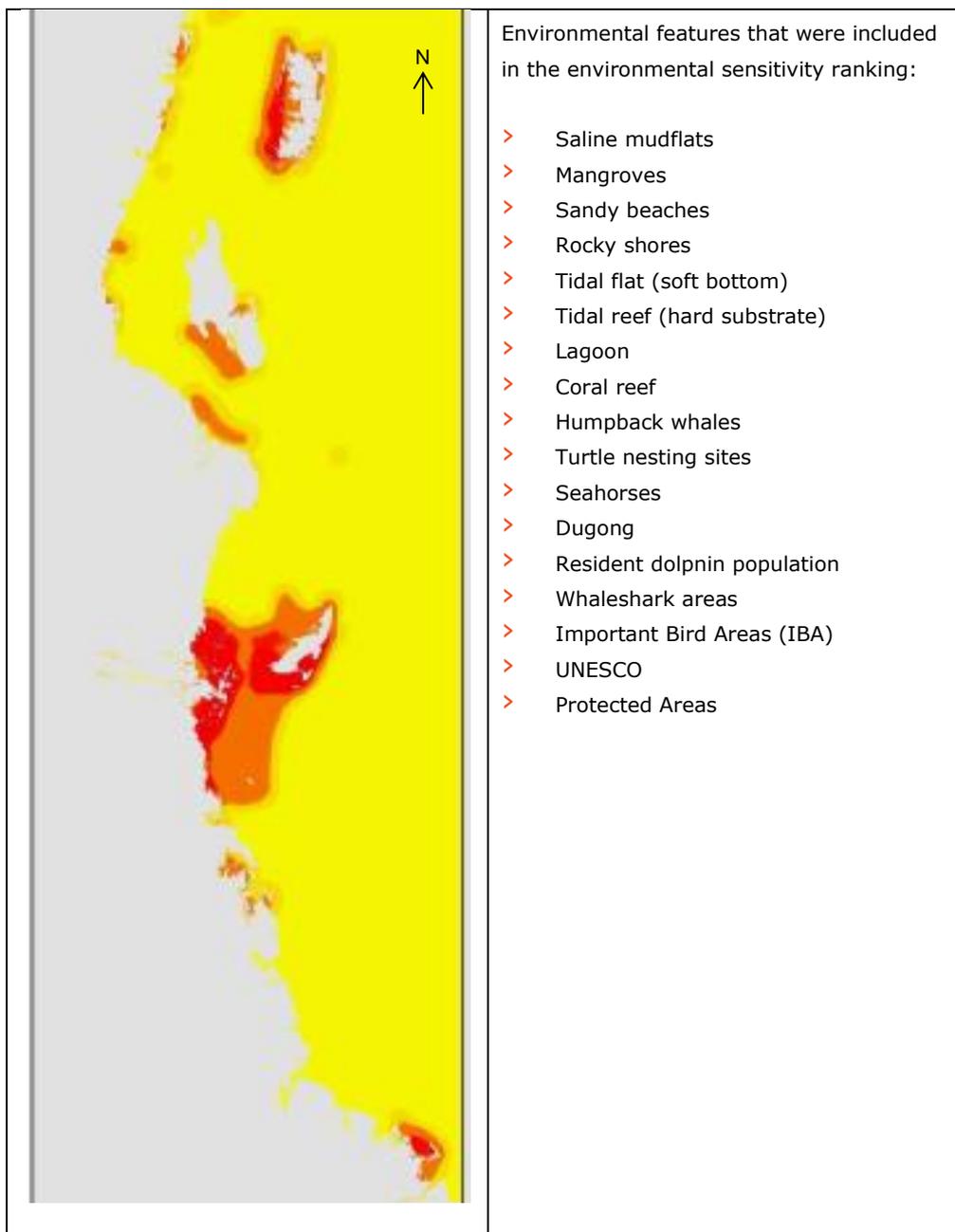


Figure 5-17 Map of environmental sensitivity to oil spills. Environmental features that were included in the sensitivity ranking are also indicated. Yellow colour = lowest sensitivity, Orange colour = medium sensitivity, Red colour = highest sensitivity (Source: TanSEA 2011).

## 5.3 Socio-economic baseline

### 5.3.1 Economic activities in the primary influence area

Apart from oil and gas exploration the following economic activities take place in the primary influence area i.e. the three subareas of Block 2, West Side, Sea Gap and Davie Ridge:

- › Oil and gas exploration;
- › Offshore deep sea fishing and
- › Shipping

#### 5.3.1.1.OFFSHORE DEEP SEA FISHING

Offshore deep-sea fishing is conducted by foreign vessels licensed by the Deep Sea Fishing Authority (DSFA). The vessels include long-liners mainly from SE Asia and purse-seiners primarily from Spain and France. In 2012 Tanzania issued 36 licences to foreign fishing vessels (DFSA data 2013) for fishing offshore. Numbers have fallen markedly compared to previous years. In 2005 a total of 192 tuna longliners and purse seiners were thus licensed to fish in the Tanzanian EEZ. Piracy has likely contributed to this significant decrease in activity (IOTC 2012).

The foreign offshore vessels target pelagic species like tunas and billfish. The primary species are: Yellowfin-, Skipjack- and Bigeye tuna. The waters offshore East Africa from Mozambique to Somalia are traditionally the most important fishing areas in the Indian Ocean (Figure 5-18 and Figure 5-19):

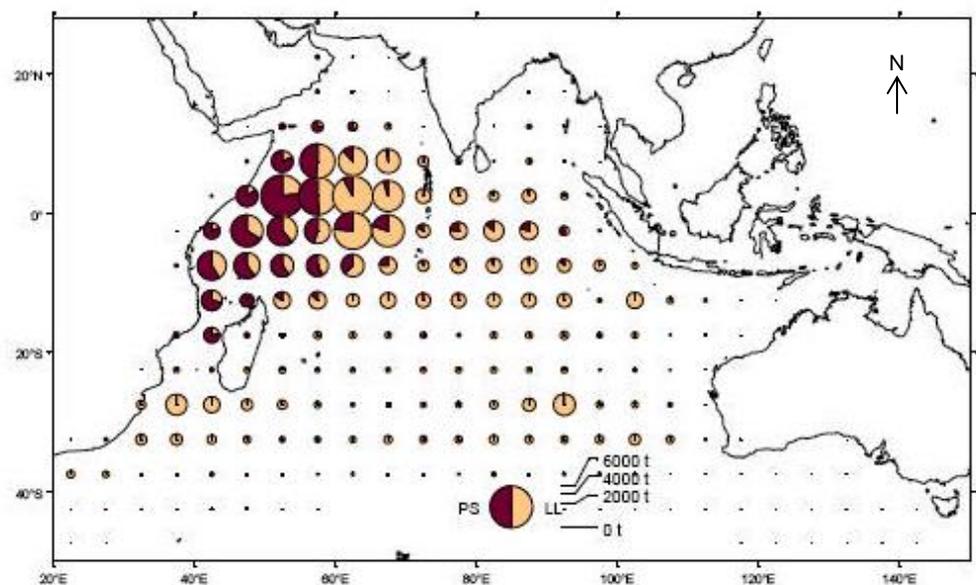


Figure 5-18 Mean distribution of catches of Bigeye tuna in the Indian Ocean 2000-2003. LL=long-liners; PS=purse seiner. (Source: IOTC, 2004).

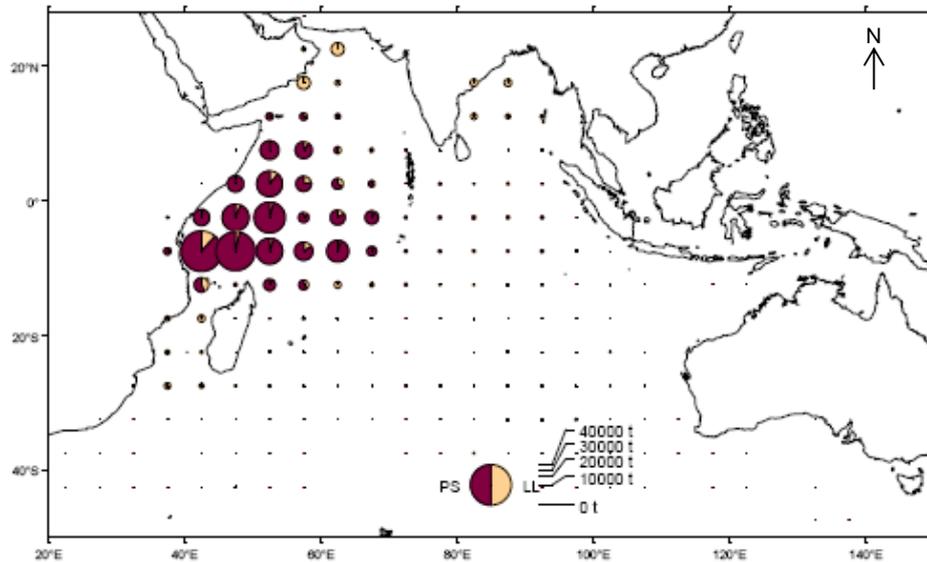


Figure 5-19 Mean distribution of catches of Yellowfin tuna in the Indian Ocean 2000-2003. LL=long-liners; PS=purse seiner. (Source: IOTC, 2004).

#### 5.3.1.2. SHIPPING

Mtwara port currently received one deep sea cargo vessel from Pacific International Lines (PIL). This vessel loads cashew nuts and transports them to Cochin in India. PIL operates container liner services covering the whole of the Far East to Europe, Black Sea, Canada, the Indian sub-continent, Red Sea/Gulf, East Africa, South/West Africa, Australia, New Zealand, East Coast of South America and West Coast of USA.

Two other cargo vessels, MV Kestrel and MV UAL Tycoon, also land in Mtwara Port. These inshore freighters travel the coastline from Mombasa, Kenya and Pemba, Mozambique. During Statoil's offshore seismic surveys in Block 2 between October 2012 and February 2013, no deep sea ships were reported.

Currently there are no cruise ships that land in Mtwara Port. Ocean cruise ships in Tanzania dock in Zanzibar and Dar es Salaam. Tanzania People's Defence force reported that piracy activities in the Horn of Africa's EEZ have severely affected trade and tourism sectors in Tanzania (Daily News January 10 2012). Cargo vessels flow in Tanzania dropped from 1,621 in 2007 to 1,228 in 2010 and has caused a loss worth between 13 to 16 billion US Dollars (ibid). In 2006, Tanzania received 20 luxury cruises, however in 2010 only 2 were recorded and currently only one (Oceana) still advertises voyages to Dar es Salaam and Zanzibar.



Figure 5-20 Navigation route for cruise ship *Oceana Nautica*. (Source. Based on Statoil 2011b)

The coastal and deep sea shipping lanes traverse through Block 2 (Figure 5-21 below). However there are no reports from either SUMATRA or TPA Mtwara on any conflicts between ongoing explorations in Block 2 and shipping lanes to date.

### 5.3.1.3. COMMUNICATION CABLES

Two fibre optic cables have been laid in the recent years along Tanzania’s coastline. In the Block 2 drilling area of influence on the SEACOM cable is relevant, extending from Mozambique into Tanzania to Dar es Salaam and beyond. However, the cable route is runs west of the Davie Ridge area and far east of the Sea Gap area and thus does not risk any impact from drilling operations.

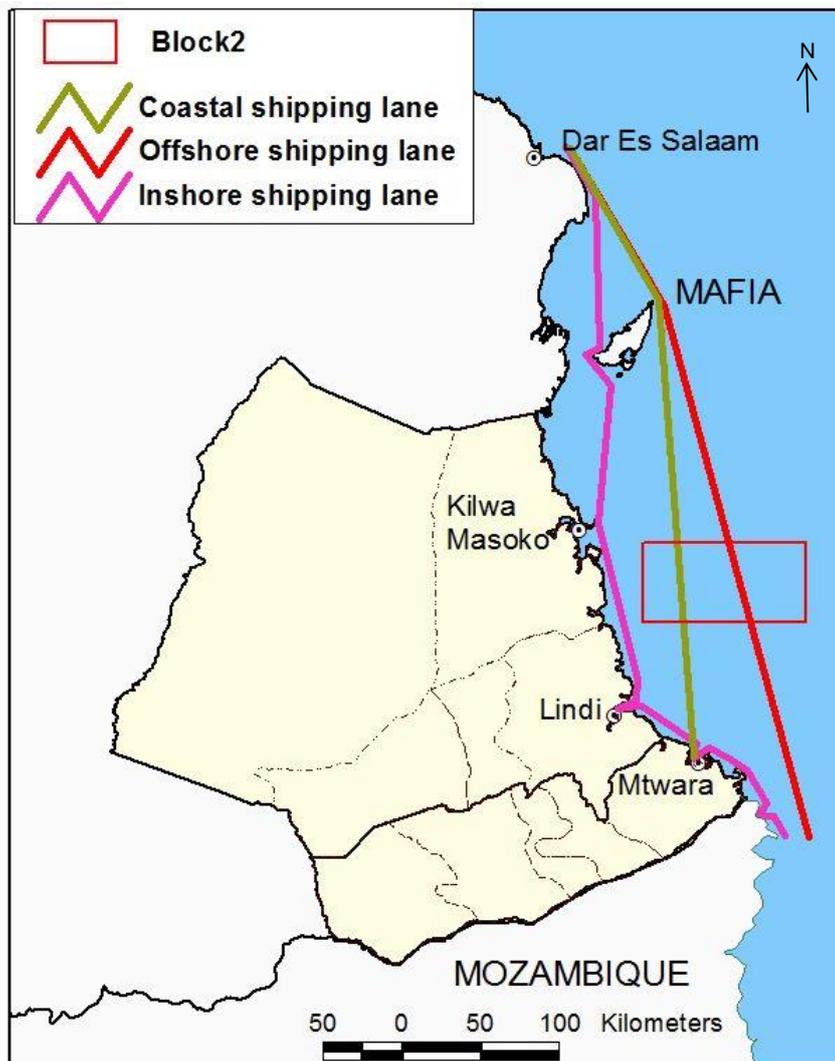


Figure 5-21 Map indicating main shipping lanes in relation to Block 2 (modified from EIS of Zafarani well, 2011)

### 5.3.2 Economic activities in the secondary influence area

The description of the socioeconomic activities in the secondary influence area includes:

- › Activities in the corridor where supply vessels travel between the drill ship and Mtwara Port;
- › Activities along the entire Tanzanian coastline and Islands with emphasis on the coastal stretch from the Mozambique border to Lindi. This stretch is situated close to the approach to Mtwara Port.

#### 5.3.2.1. FISHING

##### Coastal artisanal fishing

Tanzanian coast

Fishery is a vital resource of food and makes a valuable economic contribution to the local fishing communities along the 850 km coastline and islands of Tanzania.

Small scale artisanal fishery accounts for the bulk of the catch. Fishing takes place in shallow water within the continental shelf, by the use of traditional fishing boats such as dhows, dugout canoes, outrigger canoes and dinghies. These are built using traditional skills in all major fishing villages and landing sites along the coast. They may or may not be motorized.

The most commonly used fishing gear is various types of nets, hook and line, basket traps and fence traps. More than 500 species of fish are caught inshore with demersal (bottom dwelling species) being the most important group followed by large and small pelagic species.

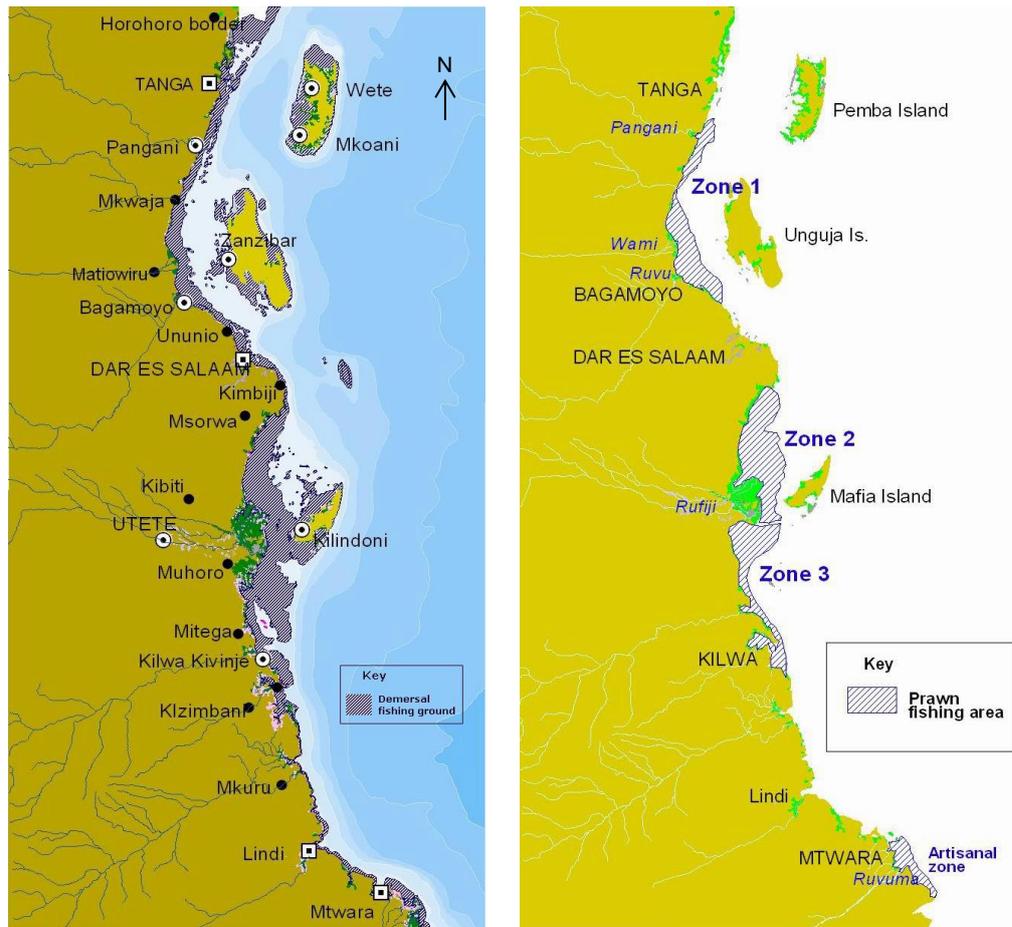
The demersal species caught are mainly emperors, groupers, goatfish and snappers. The fishing grounds for demersal species are shown in Figure 5-22.

The small pelagic fish are mainly sardines, anchovies and mackerels. They are mainly caught in the area shown in Figure 5-23. Large pelagic fish include Jacks and Trevallys, sharks, tuna, kingfish and swordfish. Fishing grounds for these species are also shown in Figure 5-23.

Most of the catch is used for subsistence purposes. However, octopus is sold locally and also exported to Kenya, the Middle East and Spain (Jiddawi and Ohman 2002). Some shellfish and sea cucumbers are exported to the Middle and Far Eastern markets. Lobsters are exported to Europe and the Far East.

Access to the outer-reef is strongly affected by seasonal winds especially during the SE monsoon period (Labrosse et al. 2005). During this period the fishers traditionally migrate between Mtwara and fishing grounds off Kilwa District and around Mafia Island and Zanzibar.

Trawling for prawns, which is Tanzania's only inshore industrial fishing industry, is also carried out along the coast. The prawns are caught in the shallow waters off the Rufiji delta and Bagamoyo/Saadani in northern Tanzania and at Mtwara (Figure 5-22). Five different species are caught the Indian white shrimp (*Penaeus monodon*), the Speckled shrimp (*Metapenaeus monoceros*), the Green Tiger shrimp (*P. semisulcatus*), the giant Tiger Prawn (*P. monodon*) and Peregrine Shrimp (*M. stebbingi*) (Nhwani et al. 1993).



Fishing grounds for demersal fish

Fishing grounds for prawns

Figure 5-22 Fishing grounds for demersal fish and prawns along the coast of Tanzania (Source: Muhando and Rumisha 2008).

#### Mtwara-Lindi coast

The Mtwara – Mikindani district has a coastal strip of 25 km. Fishing is done locally mostly on territorial water not more than 12 nautical miles from the shore.

The average annual catch is 385 metric tonnes. Catch and number of boats is recorded at Shangani Ferry. About 600 fishers and 350 vessels are registered in the area. Fishing is mostly carried out from dugout canoes which carry 1-2 fishers. There are 200 basket traps, 10 Ring nets, 400 gillnets, 5 long lines, 150 hand lines and 50 shark nets.

The fishing industry is facing many problems, including low income, inadequate fish processing facilities, lack of modern fishing gear and technologies and lack of entrepreneurship skills.



Fishing grounds for small pelagic fish

Fishing grounds for large pelagic fish

Figure 5-23 Fishing grounds for small and large pelagic fish along the coast of Tanzania (Source: Muhandi and Rumisha 2008).



Figure 5-24 Fishing vessels and fish vendors at Shangani Ferry (Source: COWI).

#### 5.3.2.2. AQUACULTURE

Aquaculture is practised in coastal communities mostly by women. The most common form of aquaculture is seaweed farming in open lagoons. A number of communities rely on this farming as an alternative source of livelihood, especially for women.

#### 5.3.2.3. SALT PRODUCTION

Salt production is carried out in small scale in scattered locations along the coast; usually in the mangrove areas. It is undertaken both seasonally and full time. Both solar evaporation pans and boiling of seawater are practised. The latter consume valuable fuel wood. The harvested salt is either sold locally or used for domestic consumption

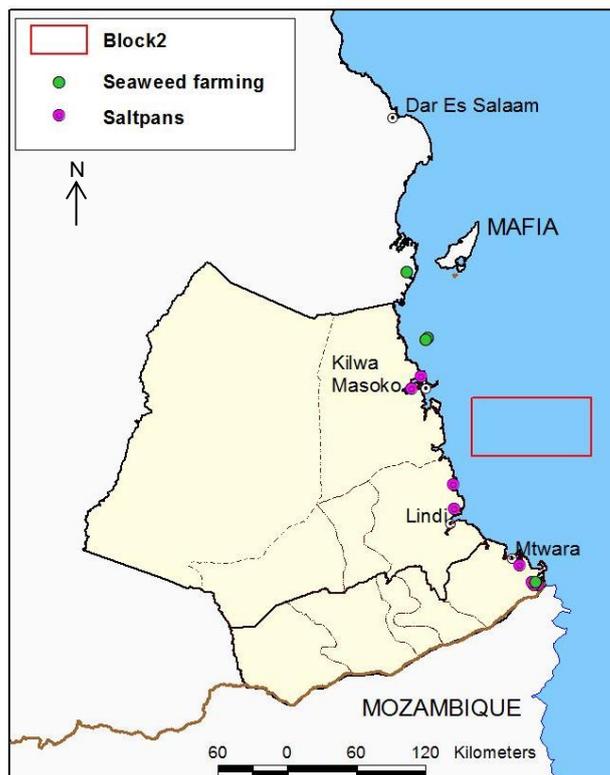


Figure 5-25. Locations of saltpans and areas where seaweed farming takes place in the southern part of Tanzania. (Source. Based on Statoil 2011b)

#### 5.3.2.4. SEA ORNAMENTS/SHELLS

A good number of women along the coast engage in shellfish harvesting and shell collection. The harvested shellfish are either sold or used for domestic consumption. Selling of sea shells provide a valuable supplementary income for families.

#### 5.3.2.5. COASTAL TOURISM

There are numerous tourist destinations along the coast of Tanzania. The attractive coastline and clean conditions of much of the coastal environment in the southern part of Tanzania has the potential to support a significantly greater tourism sector. To date there are a number of tourism hotels that rely mainly on marine-based tourism activities i.e. sport fishing, diving, snorkelling and swimming, but also cultural sites and forests e.g. unique historical ruins and sites; Swahili and dhow culture and art; local wood sculptures and Makonde carvings.

The scope for large-scale tourism is limited as a result of remoteness and lack of infrastructure. Some coastal areas are beginning to develop hotels, resorts and small-scale guest houses. There is increasing eco-tourism activity in relation to existing marine parks and reserves.

Near shore tourism activities include diving and sport fishing. Popular diving sites include Pemba Island, Zanzibar, Mafia Island, Mtwara (Table 5-2). In Mtwara diving sites are in Mikindani Bay and Mnazi Bay. Sport fishing is common in the

nearshore waters of Sinda Island near Dar es Salaam, near Mafia Island, in Mikindani Bay and in Mnazi Bay.

Table 5-2 *Main diving sites in nearshore Tanzania.*

Area	Characteristics
Pemba Island, off the coast of Tanga region	Waters near Pemba offers coral-choked walls and colourful reefs. The diving here tends to be more advanced, with depths in the 30-40 metre/100-130 foot range. Also known for the presence of whitetips, grey whalers, silvertips and the occasional hammerhead sharks.
Zanzibar	<p>Mnemba Atoll is teeming with fish and offers drift and wall diving, all with consistent 30-metre/100-foot visibility.</p> <p>Leven Bank is the domain of experienced divers looking for a unique thrill. Area is populated by big game fish, tuna, barracuda, kingfish, trevally, a variety of wrasses and huge moray eels.</p>
Mafia Island	Mafia Island has some of the richest reefs in the world with a variety of hard and soft corals and diversity of tropical fish. The warm and tropical water also attracts whale sharks from October through March
Mtwara	Mikindani and Mnazi Bays is where the Southern Equatorial Current meets the African coast creating a unique ecosystem with a wealth of marine life from across the Indian Ocean. The area is now recognized as the centre of biological diversity for the East African Coast and over 258 species of coral have been identified.

Source: [www.padi.com/scuba](http://www.padi.com/scuba) ; [www.eco2tz.com](http://www.eco2tz.com); [www.mafiaisland.com](http://www.mafiaisland.com)

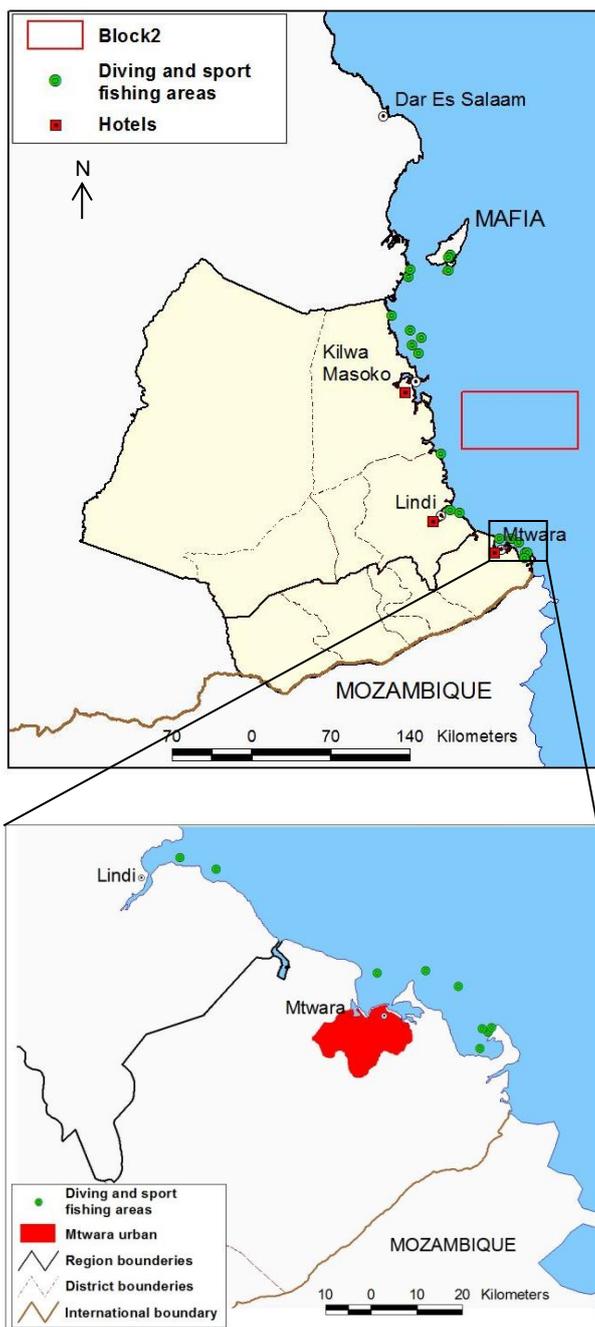


Figure 5-26. Location of hotels and diving and sports fishing areas in the southern part of Tanzania. (Source Based on Statoil 2011b)

### 5.3.2.6. COASTAL FORESTS

Natural forests within the coastal zone, including mangroves, provide construction materials, fuel wood, and charcoal as well as supporting beekeeping.

Especially mangroves are used for firewood and charcoal for cooking and heating, as fuel for salt and lime production and for drying, smoking and frying fish. Mangroves are also used for building poles, construction materials, boat building, fish traps, fishing stakes, tannin and traditional medicines. The mangroves are overexploited. Construction of evaporation ponds for solar salt production is believed to be the greatest threat to mangrove resources in Tanzania. 75% of the

manufactured salt is by solar production, the remaining 25% by burning mangrove as firewood. The salt pans have mostly been constructed in ecologically important Mangrove areas.

### 5.3.3 Infrastructure and Social Services Mtwara Mikindani Municipal Council (Mtwara Urban)

The Mtwara Port Base is located in Mtwara-Mikindani Municipal Council (or Mtwara Urban) in Mtwara region. The Municipal is bordered by the Indian Ocean on the east and Mtwara Rural District to the south-west and north (Figure 5-27).

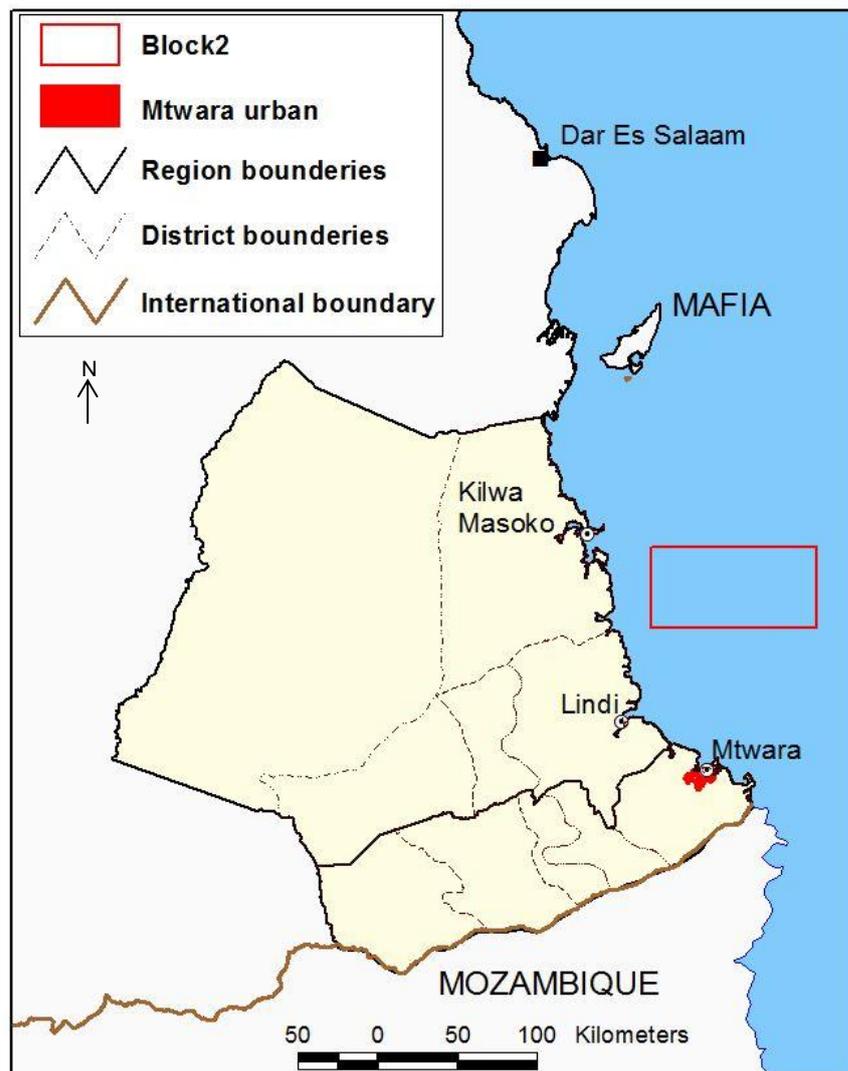


Figure 5-27 Administrative boundaries in the southern part of Tanzania. Block 2 is also shown (Source: Based on Statoil 2011b).

#### 5.3.3.1 DEMOGRAPHIC PROFILE

According to 2012 Population and Housing Census, Mtwara region has a total population of 1,270,854 people of whom 599,648 are male and 671,206 are female. Population density is 76 persons per square km while household size is 3.7 persons.

Mtwara Mikindani Municipal Council has a total population of 108,299 of which 51,062 are male and 57,237 are female. The household size is 3.8 persons.

#### 5.3.3.2. ROADS

Mtwara-Mikindani Municipal Council has road network of 174.2 km including:

- › 25 km are tarmac road;
- › 32.2 km of gravel roads and
- › 116.8 km earth roads that can be passed in all season.

The government of Tanzania has shown major achievement in developing Mtwara Development Corridor (MtDC) through upgrading of roads linking Mtwara and other part of the country. Apart from roads there are major efforts in improving ports, air transports and telecommunication.

#### 5.3.3.3. LAND USE

Major land uses in the Mtwara-Mikindani Municipality are:

- › Agricultural and open land;
- › Residential land;
- › Institutional land;
- › Commercial land;
- › Land for transport and communication and
- › Individual land.

Agricultural and open land occupies the largest land area.

#### 5.3.3.4. ENERGY

Fuel wood and charcoal are widely used for domestic uses. The source of fuel wood is mainly from the nearby forests. Kerosene is used for home lighting. As the reliability of electricity becomes accepted, and more widely available, the use of electricity for cooking and domestic lighting is likely to develop. Mnazi Bay Gas project has brought hope of having reliable source of power for the development of Mtwara.

### 5.3.4 Sensitivity ranking of the Tanzanian coastline (Socio-economy)

The TanSEA project described in chapter 5.2.5 has also prepared a map showing the sensitivity of socioeconomic activities towards oil spills (Figure 5-28). According to this map the most sensitive areas are:

- > Mnazi Bay-Ruvuma Estuary;
- > Unguja Island, the waters between Unguja Island and the mainland and the mainland coast south of Unguja Island and
- > Pemba island and the mainland west of Pemba Island

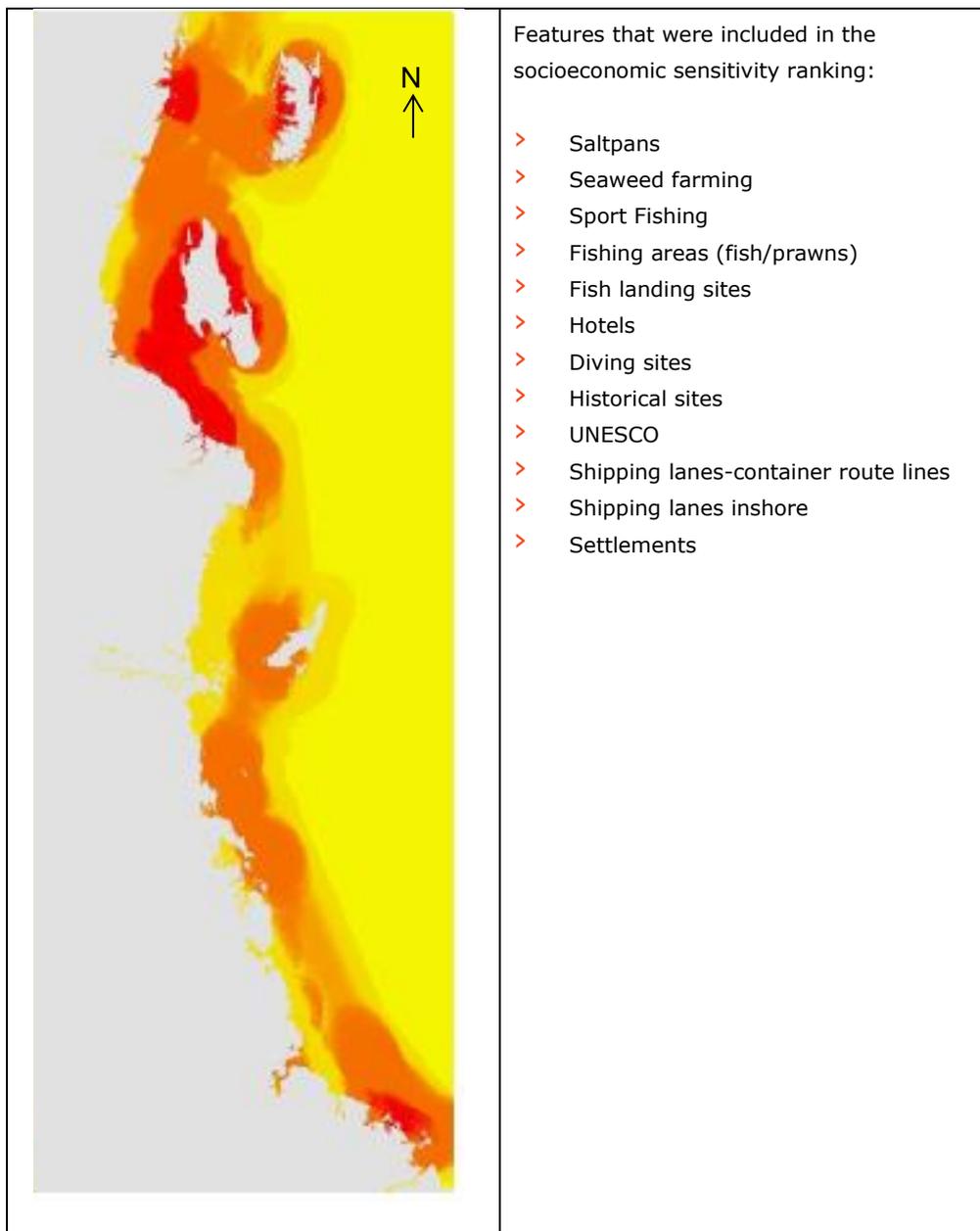


Figure 5-28 Map of socioeconomic sensitivity to oil spills. Environmental features that were included in the sensitivity ranking are also indicated. Yellow colour = lowest sensitivity, Orange colour = medium sensitivity, Red colour = highest sensitivity. (Source: TanSEA 2011)

## 6 STAKEHOLDER CONSULTATIONS

### 6.1 Stakeholders identified and consulted

The main stakeholders identified in this EIS fall under six main interest areas:

- › Offshore exploration activities;
- › Offshore transport, trade and supplies;
- › Fisheries;
- › Social and economic development ;
- › Sensitive coastal and marine habitats;
- › Waste and wastewater.

The stakeholders included government ministries, departments or agencies at national, district and local levels; private organizations (such as supply vessel and waste contractors); and representatives of fishing communities. Table 6-1 lists all the stakeholders identified and consulted as part of the EIS either by face to face interview or via written communication.

It is important to note that this EIS is for additional drilling in the same block where previous drilling campaigns have taken place. Therefore extensive stakeholder consultations and awareness at the local community level had already taken place and recorded in the previous EIS report for Zafarani-1 (Statoil 2012a).

Minutes of meetings from the Stakeholder consultations are presented in Appendix 8.1 and the Public Notice is attached in Appendix 8.2.

Table 6-1. List of stakeholders identified and consulted in the EIA

Interest	Stakeholder group	Consulted during scoping phase	Consulted during EIS
Offshore exploration activities	Ministry of Energy and Minerals		✓
	TPDC	✓	
Offshore transport, trade and supplies	SUMATRA	✓	
	Tanzania Port Authority - Mtwara Port	✓	
	Marine Rescue and Coordination (MRCC)	✓	
	Supply Vessel (KC Tamblyn)	✓	
Fisheries	Deep Sea Fishing Authority	✓	
	Tanzania Fisheries Research Institute		✓
	Department of Fisheries, Ministry of Livestock and Fisheries		✓
	Mtwara Mikindani Municipal Council Department of Fisheries	✓	
	Lindi District Council Department of Fisheries	✓	
	Local Fishers at Shangani (Mtwara Port)		✓
Social and economic development	Mtwara District Council		✓
	Mtwara Mikindani Municipal Council Department of Economic Planning	✓	
	Lindi District Council Department of Economic Planning	✓	
Sensitive coastal and marine habitats	Tanzania Marine Parks	✓	
	Mnazi Bay Rovuma Marine Park	✓	
	WIOMSA	✓	
	Institute of Marine Sciences	✓	
Waste and wastewater	Mtwara Port Waste Management Contractor (SBS)	✓	
	Mtwara Mikindani Municipal Council Department of Health/Public Health.	✓	
Offshore telecommunication infrastructure	SEACOM		✓
	Zantel EASSy		✓

## 6.2 Stakeholder opinions and concerns

### 6.2.1 Positive opinions about the project

Stakeholders had positive opinions of the project in terms of:

- › Employment opportunities;
- › The development of gas to energy and
- › Possibilities of growth in the service industry.

#### Employment opportunities

Some stakeholders are optimistic that on-going offshore activities will result in more employment opportunities for Tanzanians both onshore and offshore. Onshore employment opportunities would include workers on the supply base, service providers and suppliers of goods. Offshore employment would include crew on supply vessels. SUMATRA mentioned that provisions under the Merchant Shipping Act allowed for Tanzanians to qualify for jobs on supply vessels. However, during consultations with TPA Mtwara and the Captain of one of Statoil's supply vessels, it was confirmed that Tanzanians are only employed onshore at the supply base, with service providers such as the waste management contractor, and for the supply of goods. The primary obstacle for Tanzanians to be employed by the supply vessels is the lack of practical sea service training onboard a vessel in order to obtain their certificates to allow them to board deep sea vessels. Practical sea service training is not possible at the moment due to the lack of Tanzanian deep sea vessels for training purposes.

#### Development of gas to energy

There is optimism that the on-going exploration drilling will result in the development of gas as a source of energy. The use of gas as energy will not only boost the economic productivity of Mtwara but also in other parts of Tanzania. In addition, some income will be obtained from the exploration of gas.

#### Growth in the service industry

There is optimism that on-going drilling will have spin off benefits in the growth of the service industry in Mtwara. For example opportunities for growth in the hotel business and long term accommodation developments for staff to be based in Mtwara and increased possibilities for local suppliers to provide provisions for supply vessels and drill ships.

### 6.2.2 Negative concerns about the project

Stakeholders had negative opinions on the following issues:

- › Pollution due to oil spills;
- › Conflict with fisheries;

- › Safety of supply vessels and
- › Waste Management.

#### Pollution from oil spills

Stakeholders expressed their concern about potential oil spills as a result of deep sea explorations. It was explained to stakeholders that at the moment, Statoil are expecting gas (classification as gas well if less than 1% probability of oil), but if the explorations reach a reservoir that has oil, the drilling wells are structured so that there is preventive barriers in place to protect against such as accidental oil spills from the well. However such events are extremely rare. If more than 1% probability for finding oil, the well will be classified as an oil well and a comprehensive oil spill response plan will be prepared and implemented. In addition, Statoil has an Emergency Response Plan and all their supply vessels are equipped with oil spill combat equipment to manage any oil or diesel/fuel spills. Furthermore no reports of oil spill have been recorded in Tanzanian waters to date since offshore explorations have begun which is a positive track record.

#### Conflict with fisheries

Based on feedback from the Deep Sea Fishing Authority (DSFA), there are currently no conflict between offshore drilling activities and deep sea fishing activities and there have not been any reports of collisions. The main concern with respect to fisheries is in relation to the small scale artisanal fishers who cast their nets in the near shore areas. The fishers complain to the Local Government Authority (LGA) that their nets are sometimes destroyed by the supply vessels. The issue of supply vessels damaging the nets of small scale fishers was confirmed by both the Captain of the supply vessel and the TPA HSE officer that was consulted.

#### Safety of supply vessels

The captain of a supply vessel, which was consulted, raised the concern of safety of the supply vessels with respect to small fishers for two main reasons.

- › Firstly, the small fishing boats are not visible at night as they do not have any vessel monitoring system or adequate lighting to alert the supply vessel. This puts a strain on the supply vessel watchmen who have to look out for obstacles during their voyage;
- › Secondly, the nets used by small scale fishers are not visibly marked. Therefore the vessels sometimes navigate across them resulting in a risk of the net to be caught in the propeller or rudder of the vessel.

#### Waste management

Concerns raised by the Local Government Authority (LGA) in terms of waste relate to:

- › The location of the Mdenga Waste Management Site. Both the LGA and SBS commented that the site is too close to residents in terms of the bad smell, and

the potential health and safety risk for the local community. In addition the area gets water logged during rains;

- › Different types of waste not initially permitted for managing are being handled at the site: This was explained by SBS that their original permit was for domestic waste. However, as the offshore activities grew they have had to expand their equipment to handle different types of waste and are currently treating slop and sludge and sorting other wastes for recycling;
- › Uncertainty of how waste is treated and disposed. The LGA officer reported concerns from the community that liquid waste is being discharged from the Site. Consultations with SBS found this allegation not to be true as the slop was being stored in tanks while they were acquiring a unit to treat the slop. SBS reported that they have not discharged any liquid waste and they only received a permit to discharge in April 2013;
- › Fear of hazardous waste. The local community and LGA officers do not know the nature of the waste from the drill ship and that they may be hazardous if not disposed of properly.

### 6.3 Addressing Stakeholder opinions and concerns

The opinions and concerns raised by stakeholders have been addressed as much as possible in this EIS, outlined in Table 6-2 below and further described in chapter 8 as mitigation and enhancement measures.

Table 6-2 Response to stakeholder opinions and concerns raised

SN No	Issue raised	Recommendation	Section in the EIS report
Positive			
1	Employment opportunities on supply vessels	Collaboration between institutions involved in deep sea activities to obtain a deep sea training vessel to allow Tanzanians to complete the practical sea service training.	Mitigation measures chapter 8.4
		Collaboration between institutions involved in developing training programs that will enable Tanzanians to obtain relevant qualifications to board supply vessels. Example is to have contractual agreements with oil and gas companies to use their experts and vessels for training	
2	Development of gas to energy	Joint collaboration between oil and gas companies and TPDC through Production Sharing Agreements already exists-TPDC are holders of the exploration licence granted by the Ministry and have entered an agreement with Statoil to carry out petroleum operations. TPDC to continue monitoring on-going operations so that commercially viable discoveries can be adequately planned into the nation's energy sector development plans.	Not relevant as part of PSA
3	Growth in the service industry	Company's procurement procedures to actively promote the use of local suppliers.	Mitigation measures chapter 8.4
Negative			
4	Oil Spills	Statoil's Emergency Response Plan to be updated as national and international standards change. (Noted that Statoil cannot influence but important for NEMC to know as part of their duties when monitoring and auditing.	Not relevant-SUMATRA's responsibility
5	Damage to fishing nets	Awareness raising for fishing nets to be visibly marked so as to be detected by supply vessels at a distance	Mitigation measures chapter 8.4
6	Safety of supply vessels	Awareness raising for small scale fishers to avoid fishing at night without adequate vessel monitoring systems or lights that can alert supply vessels at a distance	
7	Waste Management	Alternative waste management site to be located for the contractor	ESMaP chapter 9.3
		Current waste management site to be upgraded by fencing and improving drainage	
		Annual audits to monitor the types and quantities of waste at the site and check the effectiveness of the waste management practices	
		Awareness raising and communication to LGA and local community.	

## 7 ASSESSMENT OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS

### 7.1 EIA methodology

A potential impact is defined as a change on the environmental and socio-economical components that could result directly or indirectly from project implementation. Impact assessment is based on a comparison of environmental scenarios, viz. the existing scenario prior to project implementation (baseline situation) and the expected scenario after project implementation.

#### Assessment of environmental significance of an impact

Qualitative assessments of environmental significance of impacts of different operations and events during exploration drilling have been carried out. The assessment of include the following steps:

- › Assessments of nature, extension, duration and magnitude of impacts using the criteria shown in Table 7-1; including whether the impact is positive, negative, temporary or permanent
- › Assessment of significance of impacts combining the assessments of extension-, duration- and magnitude of the impacts using the criteria shown in Table 7-2 and Table 7-3

Table 7-1 *Criteria for assessment of nature, extension, duration and magnitude of impacts.*

<b>Criterion</b>	<b>Description</b>
<b>Nature</b>	<b>Nature of the environmental change</b>
Positive	Beneficial environmental change
Negative	Adverse environmental change
<b>Extension</b>	<b>The geographical area that may be affected by the impact</b>
Local	Only the place where the activities directly related to drilling operations may occur, located within the boundaries of Block 2 area
Regional	Regional effects. Effects may occur in the coastal area and offshore areas between Mozambique border and Lindi
National	Effects may occur along the entire coast and offshore waters of Tanzania
International	Tanzania and neighbouring countries
<b>Duration</b>	<b>Period along which the impact is expected to occur*</b>
Short-term	Less than 6 (six) months
Medium-term	Between 1 (one) and 5 (five) years
Long-term	More than 5 years
<b>Magnitude</b>	<b>Effect on environmental and social processes</b>
Low	Small effect on functioning of environmental and social processes
Moderate	Functioning of environmental and social processes is moderately affected
High	Functioning of environmental and social processes is considerably affected

Table 7-2 Criteria for assessment of significance of potential impacts of the project.

Significance rating	Relation with the criteria on nature-, extension-, duration- and magnitude that describe the impact
Positive impact	
No impact	The assessed ecological or socioeconomic feature or issue is not affected
Insignificant impact	Low Magnitude, with any combination of other criteria.
Minor impact	1) Low Magnitude, with any combination of other criteria (except for Long-term Duration and National or International Extension) or  2) Moderate Magnitude, with Local Extension and Short-term Duration.
Moderate impact	1) Low Magnitude, with National or International Extension and Long-term Duration; or  2) Moderate Magnitude, with any combination of other criteria (except for: Local Extension and Short-term Duration; and National Extension and Longterm Duration  3) High Magnitude, with Local Extension and Short-term Duration;
Major impact	1) Moderate Magnitude, with National or International Extension and Long-term Duration;  2) High Magnitude, with any combination of other criteria (except for Local Extension and Short-term Duration)

### Risk assessment

Qualitative environmental risk assessments of different operations and events during exploration drilling have also been carried out. By environmental risk is understood the combination of the significance of an impact and the probability that an impact actually will occur. The risk assessment therefore includes the following steps:

- › Assessment of the probability that the impacts will occur using the criteria shown in Table 7-3.
- › Assessment of environmental risk combining consequence and probability and of impact according to the diagram in Table 7-4.

Table 7-3 Criteria for assessment of probability of impacts

Probability criterion	Degree of possibility of impact occurrence
Very low	The possibility of occurrence is very low, either due to the project design or due to the project nature, or due to the characteristics of the project area
Low	The possibility of occurrence is low, either due to the project design or due to the project nature, or due to the characteristics of the project area
Probable	There is possibility of impact occurrence
Highly Probable	Possibility of impact occurrence is almost certain
Definite	There is certainty that the impact will occur

Table 7-4. Qualitative risk assessment matrix.

Probability	Significance /severity of impact			
	Insignificant Impact	Minor impact	Moderate impact	Major impact
Definite	Negligible risk	Low risk	Significant risk	High risk
Highly probable	Negligible risk	Low risk	Significant risk	High risk
Probable	Negligible risk	Negligible risk	Low risk	Significant risk
Low	Negligible risk	Negligible risk	Low risk	Low risk
Very low	Negligible risk	Negligible risk	Negligible risk	Low risk

Project Phases

Impacts were assessed for each of the four project phases:

- > The site selection and design phase;
- > The mobilization/site preparation phase;
- > The operation (well-drilling and drill stem test) phase and
- > The decommissioning phase.

Operations/actions causing the impacts

For each phase (when relevant) the impacts of the following operations actions were assessed:

- › Discharge of ballast water;
- › Discharge of cuttings and drilling mud components;
- › Other discharges (rig chemicals, cooling water, deck drainage and wastewater);
- › Waste generation;
- › Emissions to air;
- › Noise and disturbance;
- › Transport and
- › Accidental spills (spill from drill ship or supply vessels, spills due to collisions or uncontrolled blow-out).

Impact features and issues

The impacts of these operations/actions was assessed for

- › Environmental conditions including:
  - › Air Quality;
  - › Water Quality;
  - › Plankton;
  - › Deep water benthic invertebrate fauna;
  - › Fish;
  - › Marine turtles;
  - › Marine mammals;
  - › Birds;
  - › Mangroves;
  - › Corals;
  - › Seagrass;
  - › Protected Areas and
  - › Terrestrial ecosystems

- › Socioeconomic conditions and economic activities including:
  - › Population;
  - › Deep seas fisheries;
  - › Artisanal fisheries;
  - › Tourism and
  - › Coastal industries (seaweed farming, salt production etc.)

## 7.2 Environmental Impacts

### 7.2.1 General

Environmental impacts of the drilling operations are mainly expected to be consequences of planned discharges of cuttings, drilling mud and other drilling related chemicals and of accidental spills of oil or chemicals into the environment. The following types of impacts are assessed in the EIS:

- › Effects of planned discharges to the sea;
- › Effects of noise, disturbance and establishment of exclusion zone during the drilling operation;
- › Generation of waste;
- › Emissions to the atmosphere and
- › Effects of accidental spills

The identified potential impacts have been assessed and evaluated for each of the following phases:

- › The site selection and design phase;
- › The mobilization/site preparation phase;
- › The well drilling phase and
- › The demobilization phase

In addition cumulative effects, including the effects of drilling several wells in the Block 2 area have been assessed and evaluated.

## 7.2.2 Impacts during the site selection and design phase

The site selection and design phase is a planning phase that will not affect the environment.

## 7.2.3 Impacts during the mobilization/site preparation phase

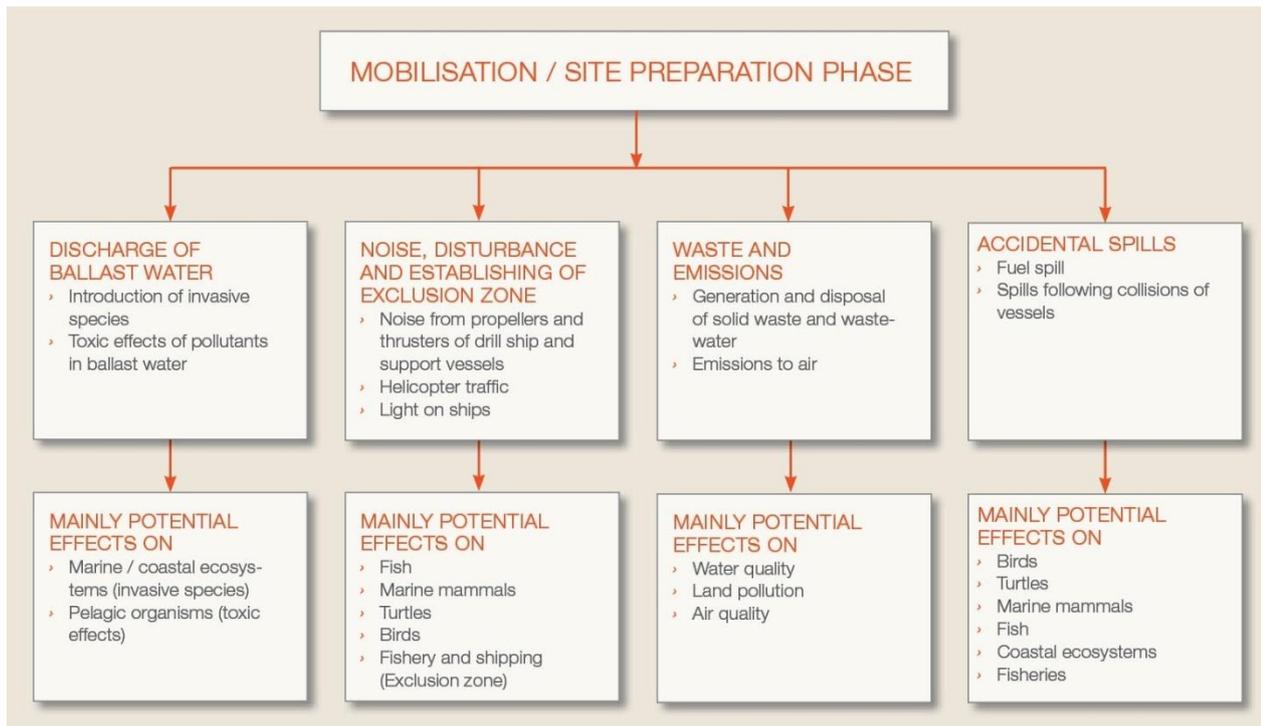
### 7.2.3.1. POTENTIAL IMPACTS

The mobilisation/site preparation includes:

- › Arrival and positioning of drill ship;
- › Arrival of supply vessels;
- › Mobilisation of chemicals, drill casings etc. at Mtwara Port, transport of the materials to the drill ship and loading the drill ship and
- › Conducting a seabed survey using a Remotely Operated Vehicle (ROV) to obtain images of the seabed and confirm that there are no obstacles or structures around the well location that may affect drilling operations.

During the mobilization phase the following potential impacts may occur (Cf. Figure 7-1):

- › Effects of discharge of ballast water that may potentially introduce alien invasive species to the area and be toxic to marine organisms in case the drill ship and supply vessels arrive from outside the East African Region;
- › Effects of noise from drill ship and supply vessels that may potentially disturb marine organisms such as fish, marine mammals, turtles and sea birds;
- › Air pollution;
- › Establishment of exclusion zones that may affect fishery and shipping and
- › Effects of accidental spills that may potentially affect marine organisms such as sea- and coastal birds, turtles, marine mammals, fish, coastal ecosystems and fisheries.



*Figure 7-1 Overview of operations during the mobilization/site preparation phase that may have an impact on the environment and organisms that may primarily be affected by the different operations that has been assessed in the EIS report. (Source: COWI).*

### 7.2.3.2 ASSESSMENT OF IMPACTS OF DISCHARGE OF BALLAST WATER

During their journey from the previous operation area to the Block 2 area the drill ship and supply vessels travel with ballast water.

Ballast water is seawater pumped in to maintain safe operating conditions throughout a voyage. This practice reduces stress on the hull, provides transverse stability, improves propulsion and manoeuvrability, and compensates for weight lost due to fuel and water consumption. Since all ships are designed for a certain weight range, ballast is used to compensate for unloaded cargo.

After arrival and when the vessels are loaded with drilling mud, drill, pipes, casings etc. ballast water is discharged. This water contains organisms from the waters where the ballast water was taken in. If the vessel arrives from other parts of the world the water may contain organisms that may be alien to Tanzanian waters, including bacteria and other microbes, small invertebrates, eggs, cysts and larvae of various species. In some cases, even healthy, living fish have been found in ballast tanks.

Marine plants and animals can be transported huge distances in ballast water. Most do not survive when the water is discharged but some do and if proper mitigating measures are not taken the discharge of ballast water may introduce foreign invasive species to the area.

Non-native species may be introduced far beyond their normal geographic ranges. Such introductions may set up circumstances that allow a species population to grow unchecked by their natural predators. The success of introduced species can depend on several factors including lack of natural predators, abundance of food sources, better tolerance of pollution (or pollution decreases that allow an invader to get a foothold), disease and other stressors, and out-competing a less aggressive species that currently occupies a biological niche that suits the introduced species. While only a small percentage of introduced species become established in a new ecosystem, that establishment can alter the structure and biodiversity of ecosystems in the area.

Ballast water might also contain oily traces, which could pose a risk of toxicity to marine life.

The risk of introduction of invasive species via ballast water is however significantly mitigated as the ships must have a Ballast Water Management Plan in accordance with the MARPOL "*International Convention for the Control and Management of Ship's Ballast Water and Sediment, 2004*". Measures to mitigate introduction of invasive species via ballast water included in a Ballast Water Management Plan is described in Section 8.2.3.

Assessment of impact significance and environmental risk of discharge of ballast water during the mobilization phase

For the first drilling operations in Block 2 the drill ship will arrive from Mozambique with a marine ecosystem similar to that in Tanzania, so in that case there will be no impact and there is no risk of introducing alien species via ballast water (Table 7-5). This applies as long as *Discoverer America* is being used.

Although it is the plan to use the drill ship for a period of 30 months, another drill ship arriving from areas far from East African waters cannot be excluded for future wells. The risk assessment of impact significance and environmental risk for this case is shown in Table 7-6.

Environmental impact significance

It has been assessed that the impacts of discharge of ballast water in this case is "*minor*", negative and temporary.

Environmental risk

The environmental risk has been assessed as "*negligible*". This is due to the mandatory mitigating measures implemented in the Ballast Water Management Plan.



*Table 7-6 Impacts of discharge of ballast water from drill ship or supply vessel arriving from areas far from East Africa during the mobilization phase.*

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No Risk
Water quality	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Plankton	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Benthic fauna	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Fish	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Marine turtles	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Marine mammals	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Birds	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Mangroves	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Coral reefs	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Seagrass	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Protected areas	Regional	Medium term	Low	Minor impact	Low	Negligible risk
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No Risk

### 7.2.3.3. EFFECTS OF NOISE FROM DRILL SHIP, SUPPLY VESSELS AND HELICOPTERS

Potential environmental impacts of noise are described in section 7.2.4.6 below as the most significant impact of noise will take place during the drilling phase. The duration of noise generation during the mobilization phase is only a tiny fraction of the duration during the operation (drilling) phase.

### Assessment of impact significance and environmental risk of noise during the mobilization phase

The results of the assessment of impact significance and risk assessment of noise from drill ship, supply vessels and helicopters during the mobilization phase is shown in Table 7-7.

Environmental impacts significance

It has been assessed that the impacts of noise during the mobilization phase is negative, temporary and "insignificant" or has no impact depending on the environmental feature in question.

Environmental risk

The environmental risks range from "no risk" to "negligible risk"

The arguments for these assessments are given in section 7.2.4.6 for the operations phase

Table 7-7 Impact of noise from drill ship, supply vessel and helicopters during the mobilization phase.

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No risk
Water quality	No impact	No impact	No impact	No impact	No impact	No risk
Plankton	No impact	No impact	No impact	No impact	No impact	No risk
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No risk
Fish	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Birds	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No impact
Coral Reefs	No impact	No impact	No impact	No impact	No impact	No risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No impact
Protected areas	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Terrestrial	Local	Short term	Low	Insig-	Definite	Negligible

ecosystems				nificant impact		risk
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**7.2.3.4. WASTE AND EMISSION TO THE AIR**

Waste and emissions to air are described in sections 7.2.4.4 and 7.2.4.5 below as the waste generation and emission to air is much larger during the operation (drilling) phase compared to the mobilization/site preparation phase.

**Assessment of impact significance and environmental risk of waste generation and emissions to air during the mobilization phase**

The assessment of environmental significance and risk for waste generation and emissions to the air during the mobilization phase is shown in Table 7-8

The rationale for these classifications is given in section 7.2.4.4 and 7.2.4.5 for the operations phase.

Environmental  
impact significance

It has been assessed that the impacts of waste generation and emissions to air during the mobilization phase is negative, temporary and "*insignificant*" or has no impact depending on the environmental feature in question.

Environmental risk

The environmental risks range from "*no risk*" to "*negligible risk*"

Table 7-8 Impact of waste and emission to the air during the mobilization phase.

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Water quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Plankton	No impact	No impact	No impact	No impact	No impact	No Risk
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No Risk
Fish	No impact	No impact	No impact	No impact	No impact	No Risk
Marine turtles	No impact	No impact	No impact	No impact	No impact	No Risk
Marine mammals	No impact	No impact	No impact	No impact	No impact	No Risk
Birds	No impact	No impact	No impact	No impact	No impact	No Risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No Risk
Coral Reefs	No impact	No impact	No impact	No impact	No impact	No Risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No Risk
Protected areas	No impact	No impact	No impact	No impact	No impact	No Risk
Terrestrial ecosystems	Local	Short term	Low	Insignificant impact	Definite	Negligible risk

#### 7.2.3.5. EFFECTS OF ACCIDENTAL SPILLS

Potential environmental impacts of accidental spills are described in section 7.2.4.8 as the risk of accidental spill is largest during the drilling phase.

#### Assessment of impact significance and environmental risk of accidental spills during the mobilization phase

The assessments of impact significance and environmental risk of accidental spills from drill ship or supply vessels during the mobilization phase is shown in Table 7-9, Table 7-10 and Table 7-11. The arguments for these classifications are given in section 7.2.4.8 for the operations (drilling) phase.

#### Major spill of diesel

A major spill of diesel may cause "moderate" negative, temporary impacts on certain groups of organisms and ecosystems. However, as the probability of spill is low, the environmental risk will be "negligible" to "low" for those features that may be affected (Table 7-9).

Major spill of drilling mud

A major accidental spill of drilling mud has been assessed to cause negative, temporary "insignificant" impacts on those features that may be affected and the environmental risks has been assessed as ranging from "no risk" to "negligible risk", depending on the environmental feature in question (Table 7-10).

Impacts of small accidental spills

The impacts of small accidental spills of diesel, drilling mud and hydraulic oil has been assessed to cause "insignificant" negative, temporary impacts and the environmental risks are "negligible" (Table 7-11).

Table 7-9 Impact of accidental spill of 900 m<sup>3</sup> diesel (major spill) from supply vessel during the mobilization phase.

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Water quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Benthic fauna	No Impact	No Impact	No Impact	No Impact	No impact	No Risk
Fish	Local	Short term	Moderate	Minor impact	Low	Negligible risk
Marine turtles	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Marine mammals	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Birds	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Mangroves	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Coral reefs	Regional	Medium term	Moderate	Minor impact	Low	Negligible risk
Seagrass	Local	Short term	Moderate	Moderate impact	Low	Low risk
Protected areas	Local	Short term	Moderate	Moderate impact	Low	Low risk
Terrestrial ecosystems	No impact	No Impact	No Impact	No Impact	No Impact	No Risk



*Table 7-11 Impact of small accidental spills during the mobilization phase. With the criteria used there were no difference between small accidental spills of diesel, oil based mud, water based mud/chemicals or hydraulic oil.*

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No risk
Water quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Benthic fauna	Local	Medium term	Low	Insignificant impact	Low	Negligible risk
Fish	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Birds	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Mangroves	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Coral reefs	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Seagrass	Local	Medium term	Low	Insignificant impact	Low	Negligible risk
Protected areas	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No risk

## 7.2.4 Impacts during the operation (well drilling) phase

### 7.2.4.1. POTENTIAL IMPACTS

The operation (well drilling) phase includes the following main operations:

- › The drilling from drill ship;
- › Preparation of drilling mud at Mtwara Port;
- › Disposal of waste at Mtwara;
- › Transport of materials between Mtwara Port and the drill ship by supply vessels once or twice a day, covering a distance of about 100 km each way;
- › Transport of personnel and small goods between Dar es Salaam and the drill ship by helicopter (Up to ten helicopter trips per week) over a distance of 250 km each way and
- › Drill Stem Testing from drill ship.

During the operation phase the following potential impacts may occur (Cf. Figure 7-2):

- › Effects of planned discharges of cuttings, drilling mud components, rig chemicals and wastewater that may potentially affect water quality, plankton, fish eggs and larvae, pelagic fish, demersal fish and benthic invertebrate fauna;
- › Effects of noise from drill ship and supply vessels that may potentially disturb marine organisms such as fish, marine mammals, turtles and sea birds;
- › Emission to air from drill ship, supply vessels, helicopters and burning of gas in connection with drill stem test;
- › Waste generation that may cause pollution at the disposal site;
- › Establishment of exclusion zones may affect fishery and shipping and
- › Effects of accidental spills that may potentially affect marine organisms such as sea- and coastal birds, turtles, marine mammals, fish, coastal ecosystems and fisheries.

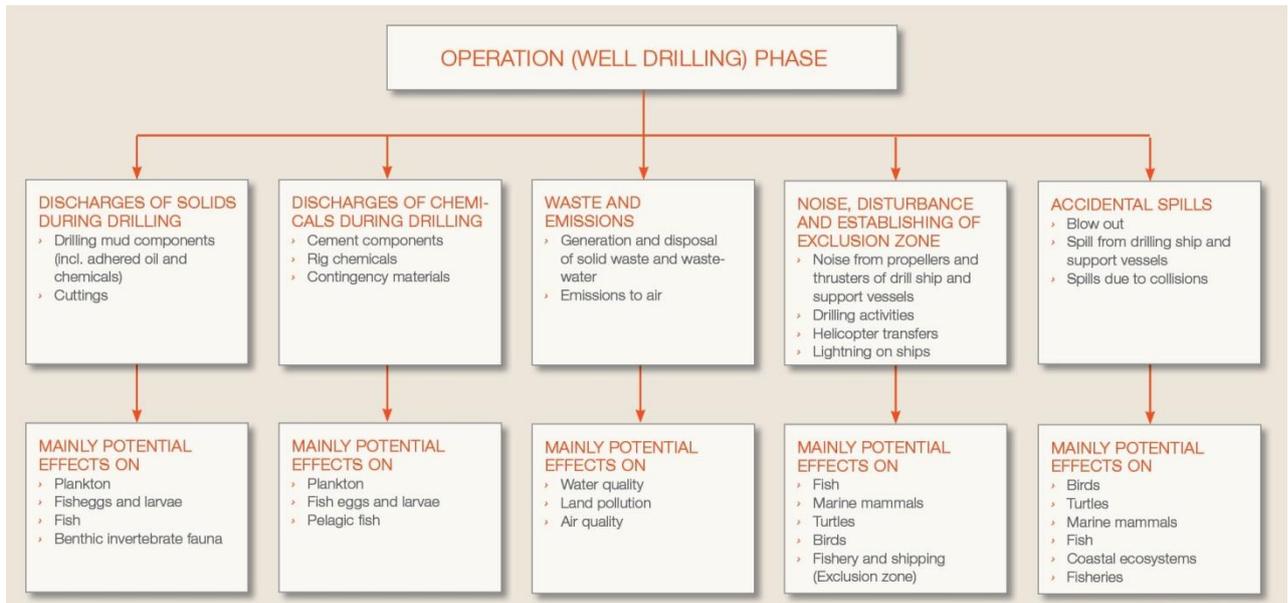


Figure 7-2 Overview of operations during the operational (well drilling) phase that may have an impact on the environment and organisms that may primarily be affected by the different operations that has been assessed in the EIS report. (Source: COWI)

#### 7.2.4.2. ASSESSMENT OF IMPACTS OF PLANNED DISCHARGES

##### Planned discharges

The planned discharges include:

- › Discharge of cuttings, drilling mud and cement;
- › Discharge of cooling water, deck drainage and wastewater

##### Discharge of cuttings, drilling mud components and cement

##### *Amounts of cuttings and drilling mud components discharged*

The most significant impact of exploration drilling, apart from the unlikely event of an uncontrolled blow out or large accidental spill of diesel, is caused by the planned discharge of cuttings with some attachment of drilling mud to the sea.

During the drilling with seawater and sweeps and water based mud (WBM) in the upper sections of the well (before the riser is established), the generated drill cuttings and spent WBM will be discharged directly to the seabed according to standard practice.

During drilling of the lower sections, when synthetic oil based mud is used, cuttings and the mud components adhered to the cuttings will be discharged from the drill ship via a chute 13 meters below the sea surface after being treated in the ships shale shaker and centrifuge. The present cuttings treatment facilities on the *Discoverer Americas* guarantee that the oil content will be less than 6.9 %. This is

a standard widely used in other countries. In case the performance of any other future drill ship will be different NEMC will be notified.

Based on this, cuttings will be discharged to sea if the oil content is lower than 6.9%. If not it will be transported to shore in skips, dried at the waste management site and transported to a cement factory for use in the production of cement. Currently there is an agreement with Tanzania Portland Cement Company in Dar es Salaam. Shipping cuttings to shore and transport onshore will raise several HSE concerns.

The amount of cuttings and different drilling mud components estimated to be discharged for the drilling of one exploration well is shown in Table 7-12. The chemicals are "*environmental friendly*" being either green or yellow with regard to the Kif classification (Cf. Section 3.5.3)

#### *Discharge of cement*

Cement is usually prepared on board the drill ship in marginally greater quantity than is expected to be required. Left-over cement is typically discharged overboard and may primarily affect the benthic fauna. However, rather small quantities of discharges of left-over cement are expected.

*Table 7-12 Estimated discharge of cuttings and drilling mud components during the planned Mronge-1 exploration drilling. The total usage of chemicals is also indicated. Klif environmental ratings of the drilling mud components are also shown.*

Product name	Function	Total usage (MT)	Total Discharged	Klif Environmental classification
<b>Cuttings</b>				
From upper section <sup>1)</sup>			850 m <sup>3</sup>	
Form Lower section <sup>2)</sup>			280 m <sup>3</sup>	
<b>Sweeps chemicals</b>				
Bentonite	Viscosifier	137	137 MT	Green
Soda ash	pH control	1	1 MT	Green
Caustic soda	Alkalinity	1	1 MT	Green
BARAZAN D	Viscosifier	7	7 MT	Yellow
<b>WBM chemicals</b>				
Bentonite	Viscosifier	19	19 MT	Green
Barite	Weighting material	129	129 MT	Green
Caustic soda	Alkalinity	0.3	0.3 MT	Green
PAC RE	Viscosifier	1.6	1.6 MT	Yellow
DEXTRID E	Viscosifier	1.6	1.6 MT	Yellow
<b>SOBM ENVIROMUL chemicals</b>				
ESCAID 110	Base oil	190	61 MT	Yellow
Barite	Weighting material	62	16 MT	Green
BARACARB 50	Lost circulation	4.5	1 MT	Green
BARACARB 150	Lost circulation	4.5	1 MT	Green
CaCl <sub>2</sub>	Salt inhibitor	13	3 MT	Green
GELTONE II	Viscosifier	11	2 MT	Yellow
EZ MUL NT	Emulsifier	7	2 MT	Yellow
Lime	Alkalinity	4.5	1 MT	Green
<b>Riser Clean Up chemicals</b>				
BARAZAN D	Viscosifier	0.25	0.25	Yellow
BARACLEAN GOLD	Surfactant	4	4	Yellow

Barite	Weighting material	6	6	Green
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- 1) Discharged directly to the seabed (due to no riser installed)
- 2) Discharged from the drill ship

**Potential impacts**

The cuttings and water based mud (WBM) from the drilling of the upper sections will be deposited directly on the seabed in the immediate vicinity of the well and may potentially impact benthic fauna.

Fate of discharged cuttings and drilling mud components

During drilling of the lower sections, where cleaned cuttings with adhered mud components will be discharged close to the sea surface via a chute, the material is dispersed in the water column in the direction of the current. The densities of the particles in the discharge are significantly higher than the ambient water and will gradually sink and settle on the seabed. Due to strong currents and the deep water in the area this material will be spread beyond the drilling site before it settles on the seabed. Residual mud components having lower and similar densities than seawater will stay in the water column and be gradually diluted or be transported over a very long distance before disposal (Figure 7-3). The plume path is mainly governed by the current directions and the current velocities.

Organisms potentially affected

The discharge plumes may potentially affect water quality and pelagic organisms such as plankton, fish eggs, fish larvae and pelagic fish.

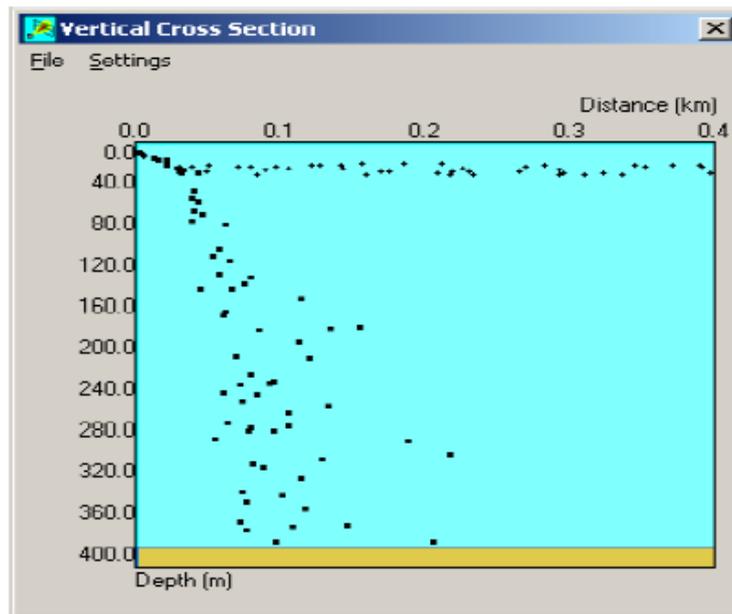


Figure 7-3 Schematic example illustrating the vertical cross section of the near field plume and the deposition of particles on the sea floor. Sea floor at about 400 m depth (Source: Ditlevsen 2011).

Effects on the seabed

However, effects of cuttings and drilling mud components are mainly expected on the seabed, where benthic invertebrate fauna and benthic fish may be affected due to:

- > Smothering;

- › Oxygen depletion due to the organic contents in the material and
- › Potential toxic effects of mud components although the discharged chemicals are all "*environmentally friendly*" being either green or yellow chemicals.

#### Modelling of impacts

The impacts of cuttings and drilling mud components discharged in the water column via the chute has been simulated for the Zafarani drilling using the DREAM model (Dose related Risk and Effect Assessment Model) developed by SINTEF Norway (Ditlevsen 2011). This simulation is representative for the future exploration drillings in Block 2.

The model calculates the fate of each component of the discharge in the ambient water under the influence of:

- › Currents (tidal, residual, meteorological forcing);
- › Turbulent mixing (horizontal and vertical);
- › Evaporation at the sea surface and
- › Reduction of concentration due to biodegradation

#### Effect calculations

The model has been used to calculate the distance from the drill ship beyond which effects of the discharge on marine organisms are not expected to occur. This is done as follows:

- › The model calculates PEC (= Predicted Environmental Concentration) for each component in the discharge at different distances from the discharge point;
- › A so-called PNEC-value (PNEC = Predicted No Effect Concentration) for each component in the discharge is determined using OSPAR guidelines and the information from the HOCNF documents for the different chemicals, i.e. the concentration of the chemical for which neither short-term or long term effects are expected;
- › The PNEC-value is then compared to the PEC value for each component. In areas where the PEC/PNEC ratio is  $< 1$  no impacts on the environment are expected (i.e. the expected concentration is lower than the concentration which is expected to affect marine organisms) and
- › Finally a single PEC/PNEC value representing the combined effect of all components is calculated.

#### Scenarios modelled

Two scenarios have been simulated:

- › A situation with a cleaning of cuttings in the cuttings treatment system to a 5 % base oil attachment (expected max value with the present system on *Discoverer Americas*) and
- › A situation with a cleaning of cuttings in the cuttings treatment system to a 1 % base oil attachment (in case a system with improved cuttings cleaning system is installed on *Discoverer Americas*)

#### Impacts in the water column

The DREAM-model simulation shows that impacts in the water column are small and with a short duration. The model shows a narrow, low concentration plume in the upper 0-100 m of the water column that travels some 16-18 km downstream from the drill ship and for both the 5 % and 1 % attachment of base-oil the results show negligible impacts in the water column (PEC/PNEC ratio < 1) (Figure 7-4 and Figure 7-5). Hence there seems to be no significant environmental benefit of reducing the SOBM content on the cuttings from 5% to 1% in these environments. In addition the plume is only observed during the period when discharge take place and once discharges cease, normal water quality will return within minutes to hours. It should also be noted that there may be long periods when drilling per se does not take place.

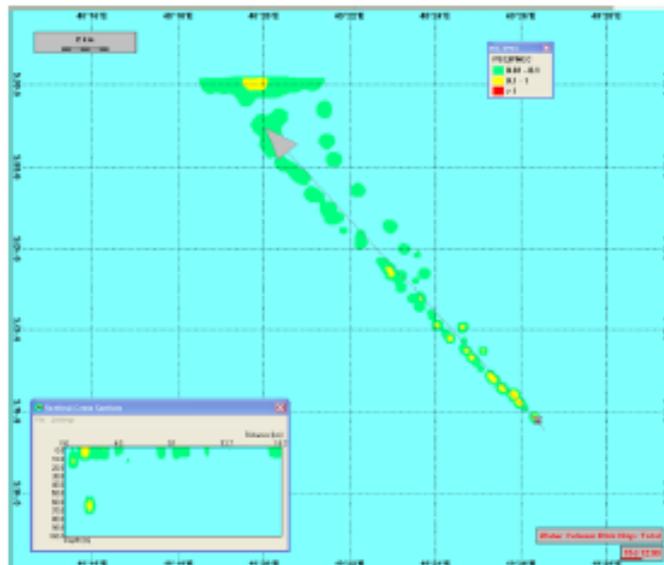


Figure 7-4 Snapshot of plume showing the simulated PEC/PNEC of the plume downstream the drill ship for 5 % attachment of Base oil (Source: Ditlevsen 2011).

The reason for the negligible effects in the upper water column is that as much as around 80 % of the discharge is cuttings that settle relatively fast and that most of the remaining 20 % of the discharge are barite, chemicals and base oil (Baroid Alkane) that tend to be adhered to the cuttings and are therefore disposed on the seabed with the cuttings.

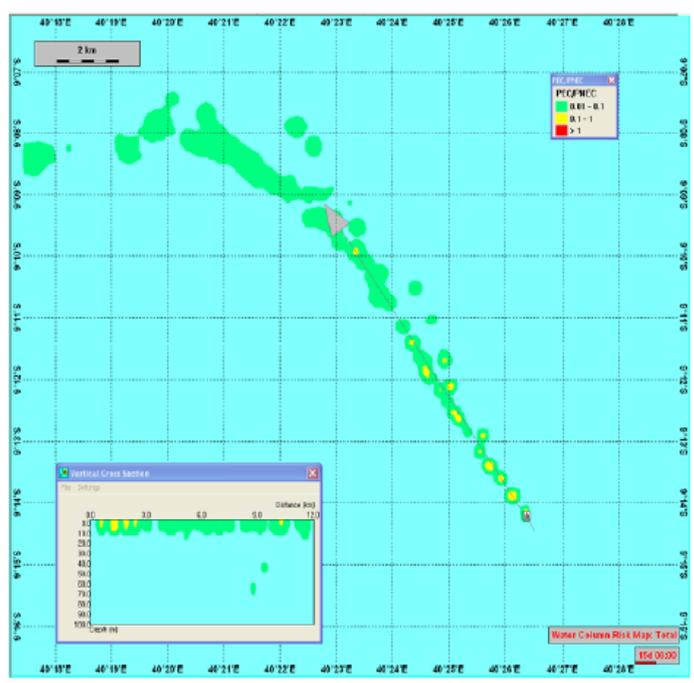


Figure 7-5 Snapshot of plume showing the simulated PEC/PNEC of the plume downstream the drill ship for 1% attachment of Base oil (Source: Ditlevsen 2011).

Impacts on the seabed

The impacts of disposal and settling of cuttings and drilling mud components on the seabed in the Sea Gap area was studied during and after the completion of the exploration drilling at Zafarani-1 and Lavani-1 in connection with the SERPENT study described in section 5.2.3.2 above. (Serpent and Statoil 2012a and 2012b).

Observations of cuttings

At Zafarani, the seabed was covered by a layer of drill cuttings extending at least 150 m to the north of the well and 30-40 m from the well in the other directions (Figure 7-6). At Lavani drilling disturbance resulted in coverage of the seafloor with drill cuttings, generally extending to approximately 60 m from the well. In the eastern and north-eastern direction the visible disturbed area extended out to a distance of 140 m from the well, probably as a result of the drilling of a pilot well to the east of the Lavani well.

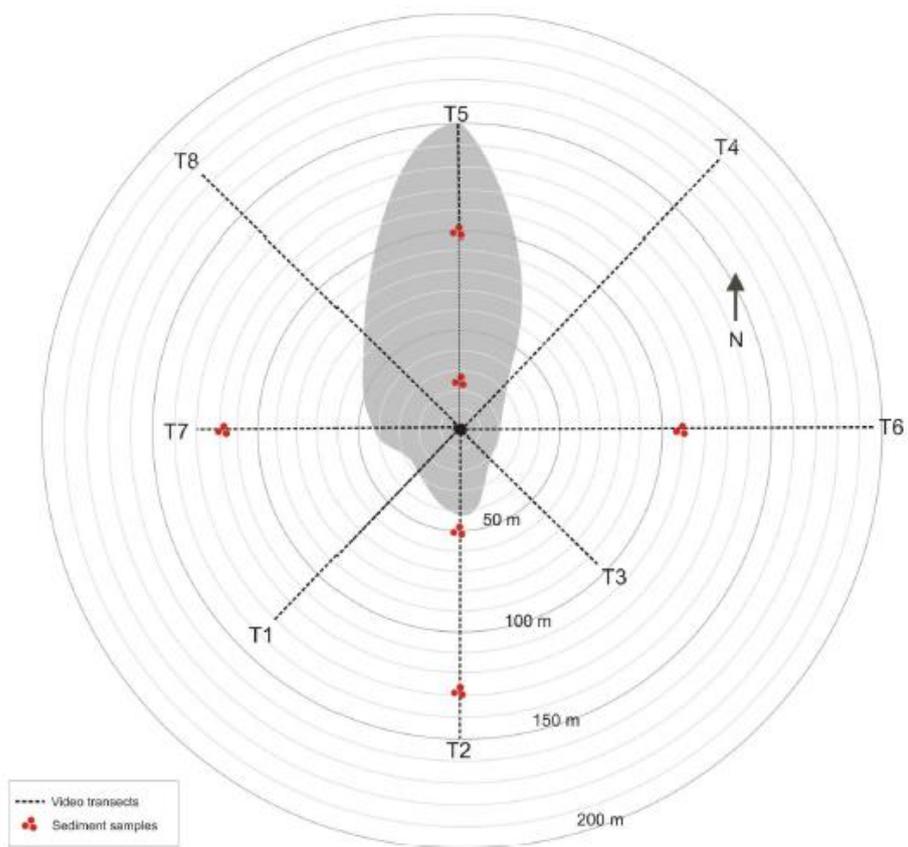


Figure 7-6 *Extent of drill cutting around the well at Zafarani. Videotransects (dotted lines) and sampling locations (red dots) for sediment are also shown (Source: Serpent and Statoil 2012a).*

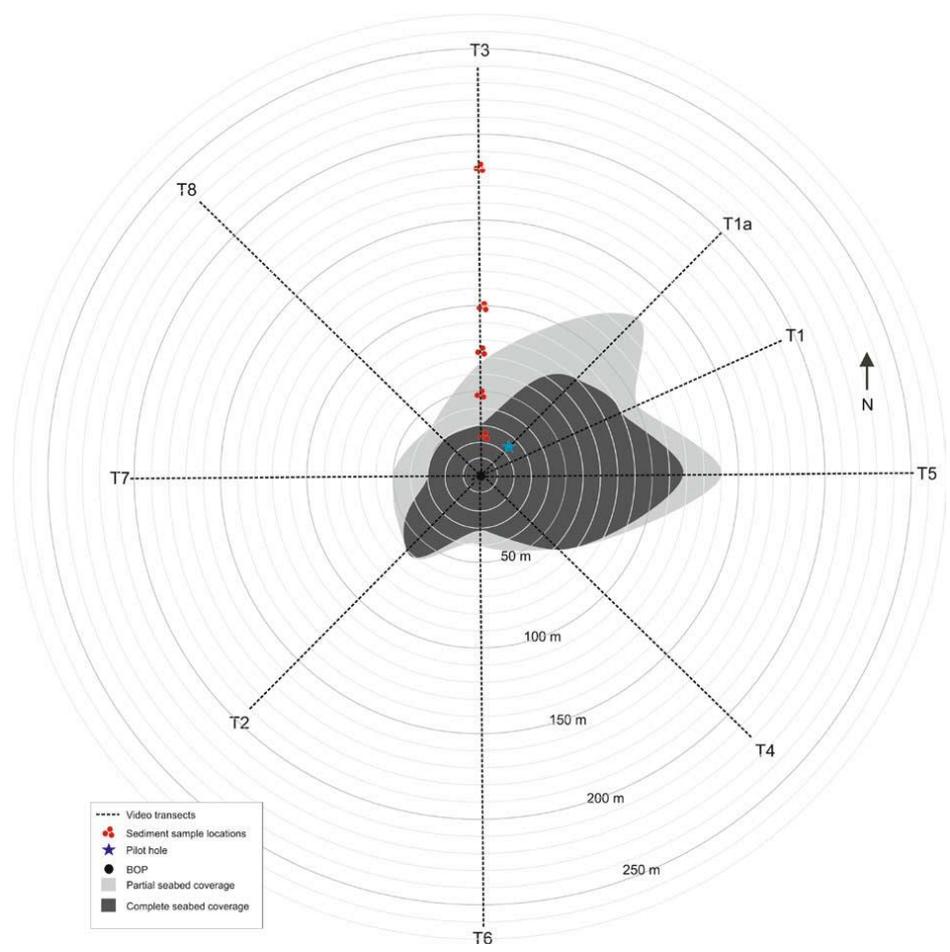


Figure 7-7 Extent of drill cutting around the well at Lavani (Source: Serpent and Statoil 2012b).

Analysis of sediments for Barium

Barium can be used as an indicator for the presence of drilling mud in the sediment. The observed drill cuttings distribution around both drilling sites were verified by markedly elevated sediment barium concentrations in the areas where drill cuttings were observed on the video and barium concentrations significantly decreased with increased distance from the well (Figure 7-8, Table 7-13).

Core samples of sediments at Lavani indicated that the layer of cuttings in the immediate vicinity of the well was 1-2 m thick decreasing to approximately 20 cm and 10 cm at distances of 25 m and 50 m north of the well, respectively. At a distance of 100 m there was no visible evidence of drill cuttings in the samples.

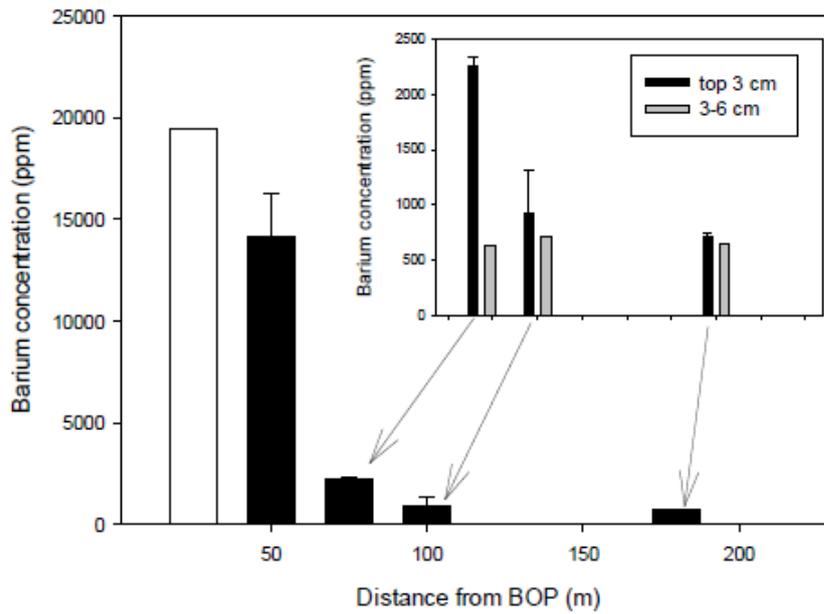


Figure 7-8 Sediment barium concentrations at increasing distance north of the well site (BOP) at Lavani. (Source: Serpent and Statoil 2012b).

Observed effects on benthic fauna

The benthic megafauna were clearly affected by the drill cuttings disturbance in the vicinity of the well site. At both wells the abundance and species diversity of benthic megafaunal organisms was significantly reduced within the areas affected by cuttings and the fauna composition in the affected areas differed markedly compared to the unaffected areas (Figure 7-9).

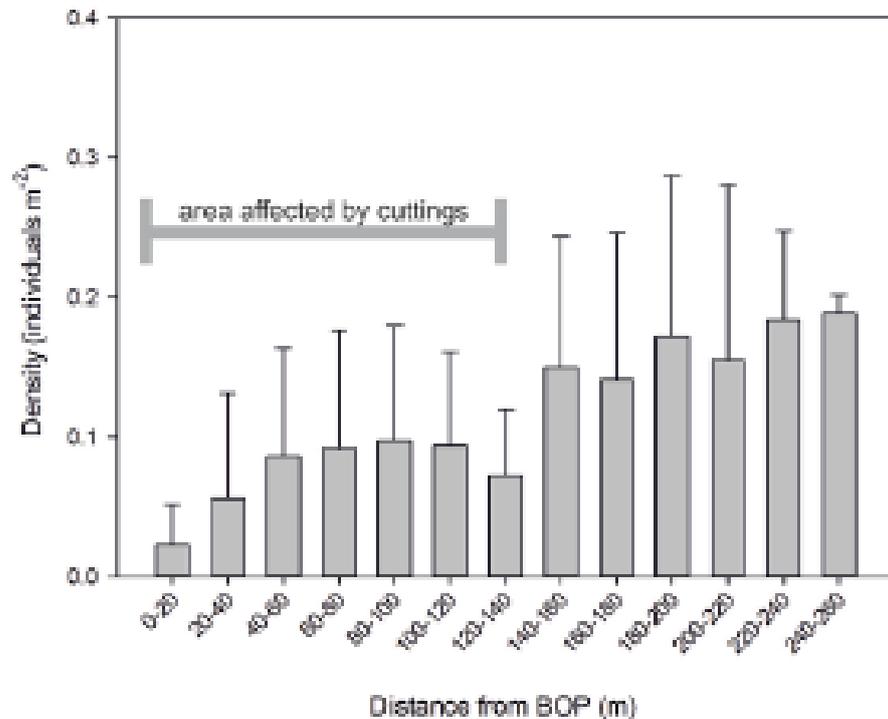


Figure 7-9 Mean abundance (± standard deviation) of megabenthic organisms at increasing distances from the well site (BOP) at Lavani. The maximum extent

*of observed coverage of drill cuttings is also shown (source: Serpent and Statoil 2012b)*

The deleterious impacts on the benthic fauna in the affected areas are expected mainly to be a result of physical smothering by particulate matter. Toxic effects of heavy metals in the barite and bentonite may also be a factor.

Comparison with sediment quality criteria

Some of the data on sediment chemistry which were collected at Zafarani by the SERPENT project were compared with Canadian Sediment Quality Criteria in order to assess the potential for adverse biological effects due to heavy metals (CCME 2013). These criteria are based on a considerable number of field and laboratory studies on the correlation between concentration and toxicity. For selected heavy metals a probable effect level (PEL) has been established. Concentrations in sediments equivalent to and above the PEL value are expected to be frequently associated with adverse biological effects.

From Table 7-13 it appears that the concentrations of barium, arsenic, chromium, copper and zinc, which are found in the bentonite and barite in the drilling mud, are significantly elevated in the sediment within visibly affected areas compared to the concentrations outside. In addition it is evident that the concentrations of chromium and copper are higher than the PEL indicating that these metals may affect the fauna within the visibly affected area.

*Table 7-13 Concentrations of barium and selected heavy metals in the sediments around the Zafarani well after drilling compared to the Probable Effect Level (PEL) (CCME 2013).*

	Concentration in sediment <b>within</b> visibly affected area	Concentration in sediment <b>outside</b> visibly affected area	PEL
Barium (mg/kg)	228,242-440,159	799-1042	No PEL values
Arsenic (mg/kg)	21-30	3-4	42
Chromium (mg/kg)	103-269	68-86	160
Copper (mg/kg)	128-174	36-46	108
Zinc (mg/kg)	54-64	60-74	271

The observations of disturbance on the seabed at Zafarani and Lavani are largely a result of cuttings and water based mud discharged at the seabed during the drilling of the top-hole sections. It is expected that cuttings and adhered drilling mud components discharged at the surface during the drilling of the lower sections will spread beyond the drilling site before it settles on the seabed.

Results of model studies

This was confirmed by the pre-drilling DREAM model study for the Zafarani drilling (Ditlevsen 2011) of the spreading and impacts of the surface discharge of drilling mud with adhered drilling mud components including 1 % or 5% attached base oil during drilling of the lower sections of the well. The study suggested:

- › That the main impact on marine life would be relatively small and restricted to organisms on the seabed;
- › That organisms at the seabed may be affected by the discharge out to a distance of about 1 km from the well in general (although effects of the 5% attached base oil might be observed further away);
- › That the main contributor to impact was oxygen depletion due to biodegradation of organic matter in the drilling mud components followed by the mud component EZ Mul and
- › That the impact will be substantially reduced after 50-100 days.

However, it should be stressed, that this is a theoretical model result that has not been verified by actual field studies of sediment chemistry and benthic fauna composition in the areas beyond the observed impact areas in the vicinity of the well site.

#### Extent of impacts

A rather limited extent of visible seabed impacts of drill cuttings seems to be general for deep sea drilling operations. Observations around about 90 deep sea drilling sites worldwide carried out as part of the SERPENT project (of which the Zarfarani and Lavani sites were part) has shown that the extent of impacted areas on the seabed due to discharge of cuttings and drilling mud is quite small and will generally not extend beyond 100-250 m from the drilling site. The largest cuttings pile that the SERPENT project has measured thus has a radius of 250 m immediately after drilling equating an area of 0.1 km<sup>2</sup> within which the benthic fauna was disturbed (Jones et al. 2006).

#### Recovery of impacted seabed

So far the SERPENT project has studied recovery of impacted deep sea drilling sites at two locations, one in the Norwegian Sea (on 380 m depth) and one in the Faroe-Shetland Channel (on 600 m depth). The evidence from these studies suggested that significant recovery takes place within 3 years after completion of drilling. However full recovery is not completed (if that is even possible) after 10 years. (Gates and Jones 2012, Jones et al 2012).

The impact and recovery mechanism seems to be as follows:

- › During cuttings discharge, the mobile animals swim away, but the attached or slow-moving megafauna are buried in the cuttings. Beyond the most impacted area in the immediate vicinity of the well site where the cuttings deposition is low, the animals are less affected and there are smaller reductions in density and diversity;
- › After the initial smothering, mobile scavengers move back in to the disturbed area, probably taking advantage of a feast of dead and dying animals;
- › During the following years the cuttings and drilling mud components are gradually dispersed with the currents. In addition benthic invertebrate species will cause bioturbation and gradually overturn and redistribute the sediment and thus contribute to the recovery of disturbed seabed. Concurrently the

affected area will be recolonized by benthic species. The unknown rates of settlement and growth of deep-sea organisms and the unknown rate of dispersal of the cuttings prevent prediction of recolonization and recovery.

The extent of impacts of future exploration wells in Block 2 is expected to be similar to the impacts observed at Zafarani-1 and Lavani-1.

Assessment of impact significance and environmental risk of discharge of cuttings, drilling mud components and cement during the operation phase

Table 7-14 outline the results of the assessments of impact significance and environmental risk of the discharge of cuttings, drilling mud components and cement.

Environmental impact significance

It has been assessed that the impacts are negative and temporary and range from "*insignificant*" impact to "*minor*" impact for those features that may be affected.

Environmental risk

The environmental risks has been assessed as ranging from "*no risk*" to "*negligible risk*"

Table 7-14 *Impact of discharge of cuttings, drilling mud components and cement during the operation phase*

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No risk
Water quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Benthic fauna	Local	Medium term	Low	Minor impact	Definite	Low risk
Fish	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Birds	No impact	No impact	No impact	No impact	No impact	No risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No risk
Coral reefs	No impact	No impact	No impact	No impact	No impact	No risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No risk
Protected areas	No impact	No impact	No impact	No impact	No impact	No risk
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No risk

#### 7.2.4.3. Other discharges

Other discharges to sea from the drill ship and support vessels will include:

- > Deck drainage;
- > Slop water (bilge water);
- > Sewage;
- > Cooling water and

- › Contaminated water from washing the tanks on the drill ship and the supply vessels, mainly when demobilisation – but also if needed during operations

These discharges may primarily affect water quality and pelagic species.

#### Deck drainage/slop water

Deck drainage includes drainage water from precipitation, sea spray or routine operations such as deck and equipment cleaning. This water could contain minor quantities such as oil and grease residues, detergent and other cleaning or lubricating products, drilling mud, paint residues and spent materials.

Contaminated drainage water (slop water) from dirty areas on deck such as the drill deck area and from washing the tanks in which SOBMs have been stored, will be drained to tanks and treated in the slop treatment unit onboard (Cf. description of the slop treatment unit in section 8.2.4). Other drainage water from clean deck areas will go to sea.

#### Bilge water

Bilge water may contain small quantities of hydrocarbons such as diesel from the engines, lubricants, and grease used onboard the drill ship. This water will go to slop tanks and treated on the slop treatment unit onboard

#### Sewage

Sewage includes grey and black water from showers, toilets and kitchen facilities on board the drill ship and support vessels. The drill ship *Discoverer Americas* has a sewage treatment plant onboard and discharge only treated sewage that will not affect the water quality around the ship.

#### Cooling water

Cooling water are small volumes of sea water which are used to cool engines. The resulting heated water, possibly mixed with freshwater depending on engine or generator specifications, will be discharged at the sea surface from a drill ship and supply vessels and has the potential to affect pelagic organisms. However, the discharge of relatively small amounts of cooling water with a temperature which is unlikely to exceed 60°C into surface waters of 25-28 °C may have a minor effect on seawater temperature within a few meters from the discharge pipe. Volumes of heated water are small, the duration short with fast dispersion and return to ambient conditions. The impact of heated water discharge is therefore considered insignificant.

#### Assessment of impact significance and environmental risk of other planned discharge (deck drainage, bilge, sewage and cooling water) during the operation phase

It is assessed that other planned discharges during the operation phase may cause negative, temporary "*insignificant*" impacts on those features that may be affected and that the environmental risks range from "*no risk*" to "*negligible risk*" (Table 7-15).

**Table 7-15** *Impact of other planned discharges during the operation phase*

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No risk
Water quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No risk
Fish	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Birds	No impact	No impact	No impact	No impact	No impact	No risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No risk
Coral reefs	No impact	No impact	No impact	No impact	No impact	No risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No risk
Protected areas	No impact	No impact	No impact	No impact	No impact	No risk
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No risk

#### 7.2.4.4. WASTE GENERATION AND WASTE MANAGEMENT

##### Potential impacts

Drilling activities generate a variety of wastes. Inappropriate handling, storage and disposal of this waste have the potential to result in fouling/ contamination of the marine and onshore environments and cause a range of adverse effects including:

- › Toxic effects or physical damage to marine organisms;
- › Water pollution/ fouling/ contamination of the sea/ shoreline or onshore environment (onshore storage, transport and disposal activities);
- › Risks of fire and explosion and

› Risks to human health.

To mitigate such impacts, Waste Management Plans for the drill ship and for treatment and disposal onshore (SBS) have been developed and appropriate treatment facilities have been established. The various types of wastes that are generated onboard the drill ship and not treated onboard is transported to Mtwara and subsequently treated and disposed at the Mdenga Waste Management Site near Mtwara. Onshore waste Management is contacted to SBS (Supply Base Solutions). The Waste Management Plans developed for *Discoverer Americas* (part of Transocean's Environmental Management System) and the Waste Management Site at Mdenga are attached in Appendix 4.

Waste generation

The main sources of waste from the drill ship include:

- › Drill cuttings from the upper sections of the borehole using sea water and sweeps or WBM (before the riser is connected) that will be discharged directly to the sea bed. Cuttings from these sections will not contain any oil based mud. Drill cuttings from the lower sections of the borehole will be transported through the riser up to the drill ship where they are treated and discharged or transported to Mtwara for treatment and disposal if treatment on the drill ship is not possible;
- › Slop water that will be treated in the Slop Treatment Unit onboard *Discoverer Americas*. The cleaned water from the unit will be discharged and the solid material from the slop will be transported to shore for treatment at the Mdenga site;
- › Wastes from drill ship activities including maintenance by-products (lube oil and other greases), packaging waste (paper, card, wood, sacks, drums and grease/paint cans), scrap metal and empty chemical containers/drums and kitchen waste. Kitchen waste is grinded and discharged. The other categories of waste are transported onshore for treatment, recycling or disposal;
- › Sanitary waste and grey water that is treated onboard the drill ship and discharged

Table 7-16 show estimated quantities of waste expected to be generated during the drilling of one well (cuttings, sludge and slop excluded).

Table 7-16 Estimated quantities of waste expected to be generated during the drilling of one well (i.e. during 90 days) (exclusive of cuttings, sludge and slop (based on information from Statoil 2012)

Waste Type	Drill ship	Supply vessels	Shore base	Total
General waste (tonnes)	45	18	1.8	64.8
Metal waste (tonnes)	50	0.5	0.1	50.6
Wood (tonnes)	19	0.2	2	21.2
Cardboard paper (tonnes)	3	0	0	3
Plastic (tonnes)	0.9	0	0	0.9
Used lubricants, waste oil (tonnes)	19	0.7	6	25.7
Hazardous waste (tonnes)	42	0.35	0.05	42.4
Medical waste (tonnes)	0.03	0	0.03	0.06

#### Waste treatment and Management onshore

Initially Statoil's waste contractor SBS was only managing general waste and operated an incinerator on the Mdenga Waste Management Site. SBS did not have a proper waste management system in place for slop and sludge from offshore drill ships as originally this was supposed to be treated by the facilities on board Ocean Rig *Poseidon*. As these facilities did not work as intended, slop and sludge were transported to the Mdenga Site in isotanks and stored temporarily. In 2012 SBS expanded their operations also to manage cuttings, mud, slop and sludge. This included tanks to store the slop water and a slop water treatment unit (operated by the Norwegian company Nature). The waste management plan for the operations has been updated to include the expanded operations.

Statoil is monitoring the performance of SBS as the waste management contractor and will initiate work to consider measures that could lead to improving the site or potentially developing another more suitable site.

#### Employment

SBS employ 180 staff, of which 149 are Tanzanians. Other international staff comes from throughout the World including East and North Africa, Arabia, Asian and Europe. SBS has employed local women for sorting, plastic recycling, and office assistance and are currently training a woman to become a certified forklift operator. The salaries of their employees are above the national minimum wage limit. In addition SBS provide health coverage. The company also provide meals and transport to workers on the base and accommodation to those living outside Mtwara. SBS has trained their local staff in various roles including managing the incinerator, forklift operators, office management and have been able to promote some to be trainer of trainers and supervisors in various roles.

### *Treatment of cuttings with oil attached*

In some cases the cuttings might not be sufficiently treated onboard the drill ship to meet the limit of 6.9 % oil on cuttings. This might happen when drilling through cement plugs (cuttings dryer does not tolerate cement) or in case of a failure on the system. In such cases the cuttings will be placed into skip containers (Figure 7-10) and transferred to the Mdenga Site where they are laid out to dry in a bunded area before transported to the Tanzania Portland Cement Company factory in Dar es Salaam.



Figure 7-10 Skip container for transport of cuttings (Source: COWI).

### *Treatment of slop and sludge*

The slop and sludge is processed in a recently (February 2013) installed Slop Treatment Unit, operated by the Norwegian company Nature. (Figure 7-11). The treatment in the Unit is a combination of chemical treatment and dissolved air flotation. The chemicals flocculate and bind together particles, making them easier to separate, which then allows flotation by dissolved air to separate both particles and oil from the water. The result is clear water free of particles and oil and a solid residue similar to cuttings. In connection with the treatment the following analytical tests are carried out:

- › Incoming slops and sludges are analysed for percentage content of oil, water and solids;
- › Produced solids discharge is analysed for oil and water content;
- › Recovered oil is tested for contamination and
- › Processed waters are typically analysed for pH, COD, TOC, suspended solids and hydrocarbon content

The treated water is discharged once the water quality has reached the required standard. SBS has got permission from NEMC to discharge the treated water disposal offshore. If the analyses of the solid residue are found acceptable it is recycled at the cement factory in Dar es Salaam.

The drill ship Discoverer Americas has a similar slop treatment unit installed onboard and will treat the slop water to meet the standards set. Recent performance of the slop treatment unit onboard has been in the range of 12-13 ppm hydrocarbons which is below the Statoil standard on 29 ppm and the Marpol/IFC-standard of 15 ppm. The sludge will be transported to shore to the waste management site to be dried before final disposal. The recovered oil will also be transported to the waste management site for disposal.



Slop and sludge storage at Mdenga



Slop Treatment Unit at Mdenga



Solid residue from Slop Treatment Unit

Figure 7-11 The slop treatment Unit (Nature Unit) at the Mdenga site. (Source: COWI)

#### *Domestic and other Waste*

The domestic waste and some packaging are incinerated. Any used oil collected from the drill ship is also incinerated. The Mdenga site has two incinerators.

Recyclable materials are sorted and recycled including: plastic bottles, aluminium cans, drums, glass, wood and scrap metals. Plastic is currently sorted and

compressed into bails that are transported to a factory in Dar es Salaam. Aluminium cans and drums are compressed and transported to a licensed smelter in Dar es Salaam. Glass is crushed and is used by other contractors for example road construction material (Figure 7-12).



Waste sorting area at Mdenga



Compressed plastic bottles



Crushed glass



Compressed aluminium cans

Figure 7-12 Waste sorting and recycling at Mdenga Waste Management Site (Source: COWI).

**Assessment of impact significance and environmental risk of waste generation during the operation phase**

Environmental impact significance

It has been assessed that the impacts of waste generation during the operation phase are negative, temporary and "insignificant" in terms of air quality, water quality and terrestrial ecosystems. Other organisms and habitats will not be affected (Table 7-17). This is the result of an efficient waste management system.

Environmental risk

The environmental risks range from "no risk" to "negligible risk"

Table 7-17 Impact of hazardous and non-hazardous waste during the operation phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Water quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Plankton	No impact	No impact	No impact	No impact	No impact	No risk
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No risk
Fish	No impact	No impact	No impact	No impact	No impact	No risk
Marine turtles	No impact	No impact	No impact	No impact	No impact	No risk
Marine mammals	No impact	No impact	No impact	No impact	No impact	No risk
Birds	No impact	No impact	No impact	No impact	No impact	No risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No risk
Coral reefs	No impact	No impact	No impact	No impact	No impact	No risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No risk
Protected areas	No impact	No impact	No impact	No impact	No impact	No risk
Terrestrial ecosystems	Local	Short term	Low	Insignificant impact	Definite	Negligible risk

#### 7.2.4.5. AIR EMISSIONS

During drilling, exhaust from engines and power generators on drill ship, supply vessels and helicopters will be emitted. The largest portions of the emissions are nitrogen and water vapour, but exhausts also include carbon dioxide (CO<sub>2</sub>), small quantities of nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), hydrocarbons and particulate matter. The flaring of gas during Drill Stem Test will also lead to these kinds of emissions. This is discussed in section 7.2.4.7 below. The emissions may potentially cause atmospheric pollution and contribute to greenhouse gases and ozone depletion (and consequently to climate change).

#### Levels of emissions

##### *Emissions from drill ship*

The drill-ship *Discoverer Americas* runs up to six diesel engines for power generation and four mud-pumps powered by diesel engines. Emissions from these engines during combustion of fuel, is generally in the range of 30-60 m<sup>3</sup> per with an

average of 33 m<sup>3</sup> per day. Using this average figure it has been estimated that 89 tonnes of CO<sub>2</sub> and 2 tonnes of NO<sub>x</sub> will be emitted per day (Statoil 2012)(Table 7-18).

*Emissions from supply vessels*

The supply vessels will sail between the drill ship and Mtwara port once or twice a day, covering a distance of about 100 km each way. Based on information from Statoil 2012 it has been estimated that an average of 4050 tonnes of CO<sub>2</sub> and 90 tonnes of NO<sub>x</sub> will be emitted from supply vessels per day (Table 7-18).

*Emissions from helicopters*

There will be two helicopters serving the rig, with up to ten flights between Dar es Salaam and the rig per week for crew change and local service crew transport. Fuel consumption is expected to be approximately 900 litres for a round trip between Dar es Salaam and the rig. Based on information from Statoil 2012 it has been estimated that an average of 5 tonnes of CO<sub>2</sub> and 0.08 tonnes of NO<sub>x</sub> will be emitted from helicopters per day (Table 7-18).

*Table 7-18 Emissions from fuel consumption from drill ship, supply vessels and helicopters per day and per drilled well.*

	CO <sub>2</sub> emission (tonnes)		NO <sub>x</sub> emission (tonnes)	
	Per day	Per well (90 days)	Per day	Per well (90 days)
Drill ship	89	8010	2	180
Supply vessels	45	4050	1	90
Helicopters	5	450	0.08	7.2
<b>Total</b>	<b>139</b>	<b>12,510</b>	<b>3.08</b>	<b>277.2</b>

**Impacts of emissions**

Table 7-19 compares the emissions from the drilling of one well in Block 2 with the total emission in Tanzania, Africa and the World resulting from the consumption of fuel in 2011. The comparison indicates that the drilling of one well in Block 2 will contribute:

- › 0.1 % of the annual emission from Tanzania;
- › 0.0087 % of the annual emission from Africa and
- › 0.000032 % of the annual emission from the world

The contribution of CO<sub>2</sub> emissions to air from drilling activities in Block 2 is extremely small and negligible compared to total Tanzanian, African and global emissions and will not make a measurable contribution to global greenhouse gas

emissions that may cause climate change. The impacts of the drilling on local air quality are also insignificant and will not be measurable on land.

*Table 7-19 CO<sub>2</sub> emission from the drilling of one well in Block 2 compared to the Total yearly emission in Tanzania, Africa and the World resulting from the consumption of Impacts (www.eia.gov/countries).*

<b>Area/Country</b>	<b>CO<sub>2</sub> Emissions (Million metric tonnes)</b>	<b>% of Emissions from Tanzania</b>	<b>% of Emissions from Africa</b>	<b>% of total World Emissions</b>
Drilling one well in Block 2	0.01	0.1	0.0087	0.00032
Tanzania	7.23	-	0.6	0.02
Africa	1,155	-	-	3.7
World	31,502	-	-	-

### Assessment of impact significance and environmental risk of air emissions during the operation phase

The impact of air emissions is assessed to be negative, temporary and "insignificant" and that the environmental risk is "negligible" (Table 7-20).

Table 7-20 Impact of emissions to the air during the operation phase.

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Water quality	No impact	No impact	No impact	No impact	No impact	No impact
Plankton	No impact	No impact	No impact	No impact	No impact	No impact
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No impact
Fish	No impact	No impact	No impact	No impact	No impact	No impact
Marine turtles	No impact	No impact	No impact	No impact	No impact	No impact
Marine mammals	No impact	No impact	No impact	No impact	No impact	No impact
Birds	No impact	No impact	No impact	No impact	No impact	No impact
Mangroves	No impact	No impact	No impact	No impact	No impact	No impact
Coral reefs	No impact	No impact	No impact	No impact	No impact	No impact
Seagrass	No impact	No impact	No impact	No impact	No impact	No impact
Protected areas	No impact	No impact	No impact	No impact	No impact	No impact
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No impact

#### 7.2.4.6. NOISE, DISTURBANCE AND LIGHT

##### Sources of noise, disturbance and light

During the drilling operations, noise and disturbance will be generated. The major source of noise and disturbance and light are:

- › Underwater noise from ship engines, propellers and thrusters of drill ship and support and supply vessels;
- › Surface noise including:
  - › Drilling associated noise (e.g. power generation equipment, pumps, shale shakers, draw-works, hydraulic power packs, cranes, air compressors etc.);

- › Noise from helicopter flights;
- › Lightning on the drilling ship and support vessels;

Noise and light may affect marine organisms. Whales and dolphins are believed to be the organisms most sensitive to underwater noise, because they depend on the underwater acoustic environment for orientation and communication. Turtles and fish may also potentially be affected by noise. Surface noise may primarily affect birds and artificial light may potentially affect certain marine organisms and migrating birds.

#### Effects of underwater noise from drill ship

##### *Levels of underwater noise from drill ship*

The underwater noise generated by a *drill ship* has a low frequency. Therefore it attenuates little with distance and the ranges out to which drill operation noise is above the background noise levels are thus potentially quite large (Richardson et al 2006, Kyhn et al 2011) (Cf. Table 7-21).

Table 7-21 *Frequency range and underwater noise levels emitted from drill ships (Refs ERT 2006, Richardson et al 1995, Kyhn et al 2011).*

	Frequency range (kHz)	Sound level at different ranges from source (dB re 1µPa )						
		0.1 km	0.5 km	1 km	2 km	8 km	10 km	100 km
Noise level from drill ship estimated by spherical spreading	0.01 - 0.1	139-151	118-130	-	-	-	93-105	18-30
Estimated noise level from drill ship	0.01 - 10	127- 131	-	106-110	-	-	81-85	6-10
Measured Noise level from drill ship "Stena Fourth"	0.02 - 10	-	~130	-	~118	~112	-	-

##### *Effects of underwater noise from drill ship on whales and dolphins*

A number of different species of whales and dolphins may be encountered in the three subareas of Block 2, West side, Sea Gap and Davies Ridge with dolphins being completely dominating. Spinner Dolphin (*Stenella longirostris*), Spotted Dolphin (*Stenella attenuate*) and Rissos Dolphin (*Grampus griseus*) are the most abundant. (Cf section 5.2.3.1).

Humpback whale (*Megaptera novaeangliae*), Sperm whale (*Physeter macrocephalus*) and Short-finned Pilot Whale (*Globicephala macrorhynchus*) may also be encountered occasionally in few numbers depending on the season.

#### Possible effects

Whales and dolphins may be sensitive to underwater noise because they are highly vocal and dependent on sound for almost all aspects of their lives, e.g. food-

finding, reproduction, communication, navigation and detection of predators and other hazards.

The possible effects of underwater noise on whales and dolphins include (Southall et al 2007):

- › Hearing damage
- › Avoidance of the noise and other behavioural effects (such as changes in surfacing, breathing and diving behaviour, cessation of feeding, aggression, aversion and panic)
- › Masking. Because whales and dolphins depend on the underwater acoustic environment for orientation and communication an emitted whale sound can be obscured or interfered with (masked) by man-made underwater noise.

Identifying these effects, and the frequencies and levels of sound, which may cause the effects, has been the subject to considerable research. Extensive reviews are provided by Richardson et al. (1995), Southall et al. (2007) and Weilgart (2007).

Level of perception

A precondition for underwater sound to affect different whale and dolphin species is that the species in question can hear the emitted sound. Whales and dolphins differ in terms of the sound frequencies that they are able to hear. Some hear well at higher frequencies, and relatively poorly at lower frequencies. Based on a comprehensive review of effects of underwater noise on aquatic mammals Southall et al 2007 grouped the whales in terms of auditory band width in "*low-frequency whales*", "*medium frequency whales*" and "*high frequency whales*". The whale and dolphin species that may be encountered in Block 2 area are mainly "*medium frequency whales*". However, one species, the humpback whale, is a "*low frequency whale*" (Table 7-22). The humpback whale with its auditory band width of 0.007 - 22 kHz can hear the entire range of frequencies emitted from a drill ship (0.01 - 10 kHz). The "*medium frequency whales*" (four different species of dolphins and sperm whale) can only hear parts of the range of frequencies emitted.

Table 7-22 *Estimated range of frequencies that the whales and dolphins which may be encountered Block 2 are able to hear (Estimated auditory band width is from Southall et al. 2007)*

Functional hearing group	Estimated auditory band width kHz	Species represented
Low -frequency whales	0.007 - 22	Humpback whale
Mid-frequency whales	0.15 - 160	Spinner dolphin Spotted dolphin Rissos dolphin Sperm whale
High frequency whales	0.2 - 180	No high-frequency whales are encountered in Block 2

Hearing damage

It has been demonstrated that intense underwater noise may damage hearing of marine mammals. There are two levels of damage:

- › Temporary threshold shift (TTS) which is hearing loss that is subsequently recovered. The severity of TTS is expressed as the length of time that hearing is impaired, and the magnitude of the “shift” in hearing sensitivity (expressed in dB) as a result of the exposure, relative to pre-exposure.
- › Permanent threshold shift (PTS) which is a situation when the hearing sensitivity of an animal is permanently altered. Generally PTS will occur only after repeated TTS episodes or exposure to higher levels of sound than cause TTS.

Southall et al 2007 found that a sound level above 230 dB 1µPa will cause a temporary hearing loss (TTS) in whales and dolphins. The drilling will therefore not cause hearing damage to whales and dolphins i.e. the sound level 100 m from the drill site is only 127 - 151 dB 1µPa.

Avoidance and other behavioural effects

Behavioural impacts on marine mammals to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology.

The following effect levels for onset of avoidance reactions and other behavioural responses for the species that may be encountered in Block 2 have been reported:

- › Humpback whales will avoid or change behaviour at noise level above 120 - 160 dB (Frankel & Clark 1998, Biassoni et al 2000)
- › For dolphins Morisaka et al 2005 reported the onset of avoidance and other behavioural effects in response to non-pulse (continuous) noise (such as noise from drilling activities) at received levels to be in the range 120 - 130 dB re 1 µPa.
- › Sperm whales will be affected at sound levels above 110-120 dB re 1 µPa (Gordon et al 1992)

Comparing these levels with the sound levels emitted from a drill ship (Cf. Table 7-21) it is seen that the four different dolphin species may display avoidance reactions up to 1 km away from the drill ship, whereas Humpback Whales and Sperm Whales may display avoidance up to 8 km away from the drilling site. This corresponds with observations of migrating bowhead whales that avoided an area with a radius of 10 km around a drilling ship (Richardson et al. 1995). However, Humpback Whales and Sperm Whales are not very common in the area except for Humpback whales during their seasonal migration, between July and December.

Avoidance behaviour are in most cases beneficial, as it reduces the risk for hearing damages and other harmful effects by deterring the animal away from areas of high exposure. Block 2 area is not known to be an important feeding ground for whales or dolphins, though Humpback whale does migrate through its waters, at times with newly-born calves. Mindful of the small localised noise source associated

with the drilling operation, the effect on whales (in general) and dolphins may be considered negligible. In addition, any avoidance effect will terminate once drilling has ended.

Masking

Table 7-23 show the sound frequencies and sound levels emitted by toothed whales and Baleenwhales in connection with echolocation and communication.

Comparing these levels with the sound levels emitted from a drill ship (Cf. Table 7-21) it is seen that:

- › The toothed whales i.e. all the species of dolphins and the Sperm Whale that may be occasionally observed in Block 2 will not be affected by masking due to drilling because the frequencies they emit (10 -500 kHz for echolocation and 0.1 -50 kHz for communication) is higher than the frequencies emitted from the drill ship (0.01-0.1 kHz)
- › The sounds emitted by the Humpback Whale for communication will probably not be masked either. At a distance of 100 m from the drill ship the noise level emitted (139-151 dB  $\mu$ Pa) is within the range of sound levels emitted from the whale (140-190 dB  $\mu$ Pa). However, it is unlikely that any humpback will come that close to the drill ship. The Humpbacks' will avoid the noise long before it reaches the distance where masking takes place.

Table 7-23 Sound frequencies and sound levels emitted from whales and dolphins (from ERT 2006)

	Frequency range of emitted sound (kHz)	Emitted sound level (dB $1\mu$ Pa)
Toothed whales (echolocation)	10 -500	115 -240
Toothed whales (communication)	0.1 - 50	90 - 175
Baleen whales (communication)	0.01 - 50	140 -190

*Effects of underwater noise from drill ship on turtles and fish*

Marine turtles may be migrating or feeding in the Block 2 area including Loggerhead (*Caretta caretta*), Olive Ridley (*Lepidochelys olivacea*), Leatherback (*Dermochelys coriacea*), Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricate*).

The rather limited amount of studies carried out with marine turtles indicate that they are less sensitive to noise than marine mammals and the sound levels emitted from the *drill ship* during the drilling program suggests that the impact on turtles is not likely to affect the turtles that may be encountered in Block 2.

The available data show that sea turtles can detect moderately low frequency sounds (Ridgway et al., 1969 and Lenhardt et al., 1985, as cited in Moulton and Richardson, 2000). Sea turtles may be able to localise the direction from which an underwater sound is being received (Lenhardt et al. 1983 in Moulton and Richardson 2000). A small scale behavioural test with a loggerhead turtle and a green turtle in Australia indicated that at sound levels over 155 dB the turtles began to noticeably increase their swimming activity, and above 164 dB they began to show more erratic swimming patterns, possibly indicative of them being in an agitated state (Mc Cauley et al 2000). The sound levels emitted from a drill ship is below these levels at a distance of 100 m (Cf. Table 7-21). So if, the *drill ship* emits sound levels that may affect turtles, effects may be expected very close to the drill string. It is not likely that turtles will come that close to the drill ship.

The literature provides an unambiguous picture of the reaction of fish to underwater noise. Some species flee from noise and others do not react to noise. There are even evidence for that some species are attracted to noise (Scholik & Yan 2002, Nedwell et al. 2004).

The fact that offshore drilling rigs and platforms in general attracts fish and that the abundance and diversity of fish may be higher than the surrounding waters indicate that drilling noise generally do not disturb fish (Løkkeborg et al., 2002, , Soldal et al., 2002, Fabi et al., 2002, Stanley & Wilson 1997, Love et al., 2000).

#### Effects of underwater noise from supply vessels

##### *Levels of underwater noise from supply vessels*

Table 7-24 show frequencies and levels of underwater noise at different distances from various types of vessels.

*Table 7-24 Frequency range and estimated underwater noise levels emitted from different types of ships (Richardson et al 1995)*

	Frequency range (kHz)	Sound level at different ranges from source (dB re 1µPa )				
		1m	0.1 km	1 km	10 km	100 km
Supply vessel	0.1	164	-	-	-	-
Large merchant vessel	0.005-0.9	-	139-151	118-130	93-105	18-30
Military vessel	-	-	120-150	99-129	74-104	<29
Supertanker	0.02 - 0.1	-	150-163	129-142	104-117	29-42

##### *Effects of underwater noise from supply vessels on marine mammals and fish*

Comparing these noise levels with the effect levels described in the previous section it can be concluded that:

- › Whales and dolphins can hear the noise
- › Whales and dolphins may display avoidance reactions due to the noise from a supply vessel at a distance of around 1 km
- › The communication and navigation sounds emitted by whales and dolphins will not be masked by noise emitted from the supply vessel

Field studies have shown that several species of fish may be disturbed by noise from passing vessels and that they may flee from the vessel while other species are not affected (Freon et al. 1993). It has also been demonstrated that species that normally would flee from vessel noise can adapt to frequent noise and become unaffected (Steward 2003).

#### Effects of surface noise

##### *Drill ship and supply vessels*

Noise from the drill ship and machinery will range from 80-117 dBA in air (Statoil 2011). Noise emissions will have significant impact on project workers, but will be low for fishing vessels and other ships in the local area. Noise emissions will have no effect onshore due to the project's remote location.

##### *Helicopters*

Up to ten helicopter trips per week between Dar es Salaam and the drill ship will be made to supply personnel. Each flight will be crossing over Mafia Island and the protected Mafia Island Marine Park. More than 116 different species of birds have been observed and identified at Mafia Island including some 50 species of water fowl (different species of herons, waders, terns and gulls (Johnson 2002). Overflying helicopters may potentially disturb these waterfowl.

The effects of experimental overflights of aircraft and helicopters on the behaviour of waterfowls were studied at some lakes in Switzerland. The influence of type of aircraft and crossing altitude on the proportion of waterfowl showing a stressed behaviour (alarm posture, swimming, and flying) was studied. It was found that disturbed birds returned to a relaxed behaviour (resting, preening and feeding) within 5 min after the overflights. The study clearly indicated that the noise from helicopters did not influence the birds if the helicopter flew at 450 m or higher (Kommenda-Zender et al 2003). As the normal cruising altitude for the helicopters crossing is between 900 and 1500 meters it is unlikely that the birds at Mafia Island will be affected

#### Artificial light

The drill-ship will operate 24 hours per day. It will therefore be illuminated during the dark hours throughout the drilling programme. Artificial light may potentially affect certain organisms around the drill ship i.e.:

- › Artificial light may attract certain groups and species of marine life, notably plankton, some fish species such as sardines and squid – a phenomenon well known to local fishers. As open waters generally support much less marine

life than coastal waters the remoteness of the Block 2 area means that fewer marine organisms will be affected compared to coastal inshore waters. The potential effect of marine organisms is however, considered short term, not necessarily adverse and of minor significance.

- › Oceans have less artificial light sources compared to terrestrial environments. As a consequence of these circumstances marine birds and migrating terrestrial birds are highly attracted to artificial light at sea. There are examples that such illumination can have a trapping effect that leads birds to circle around the light source reducing their energy reserves and making them unable to reach the next shore (Deda et al 2006). However, in Block 2 this effect is considered negligible, as there is only a sparse occurrence of seabirds in the area and that it is not satiated in migration route for migrating terrestrial birds.

Assessment of impact significance and environmental risk of noise, disturbance and light during the operation phase.

The results of the assessment of impact significance and risk assessment of noise disturbance and light from drill ship, supply vessels and helicopters during the operation phase is shown in Table 7-25 .

Environmental  
impact significance

It has been assessed that the impacts during the operation phase is negative, temporary and "*insignificant*" or has no impact depending on the environmental feature in question.

Environmental risk

The environmental risks have been assessed as "*negligible*" for those environmental features that may be affected.

Table 7-25 Impact of noise, disturbance and light during the operation phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No risk
Water quality	No impact	No impact	No impact	No impact	No impact	No risk
Plankton	No impact	No impact	No impact	No impact	No impact	No risk
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No risk
Fish	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Birds	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No impact
Coral Reefs	No impact	No impact	No impact	No impact	No impact	No risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No impact
Protected areas	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Terrestrial ecosystems	Local	Short term	Low	Insignificant impact	Definite	Negligible risk

#### 7.2.4.7. DRILL STEM TEST

During the Drill Stem Test cement cuttings, drilling fluid components and clean-up chemicals are discharged to the sea and may primarily potentially affect the seabed and seabed fauna.

The flaring of gas during Drill Stem Test will emit carbon dioxide (CO<sub>2</sub>) and small quantities of nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), hydrocarbons, and particulate matter to the atmosphere.

Amounts and impacts of cement cuttings and drilling fluid components discharged during DST of Zafarani 2.

The amount of cement cuttings and different chemicals estimated to be discharged during the DST of Zafarani 2 is shown in Table 7-26. The chemicals are "environmental friendly" and not toxic. They are thus either green or yellow with regard to the Klif environmental classification (Cf. Section 3.6.3).

The cement cuttings are expected to be disposed on the seabed mostly on top of an area already affected by the exploration drilling of the well. Based on the experience from Zafarani 1 this area is expected to extend some 30-150 m from the wells site depending on direction. The drilled out chemical cuttings will be hard cement and chemicals will not be released to water.

Table 7-26 *Estimated discharge of cement cuttings, drilling fluid components and clean up pill spacer during the Zafarani 2 Drill Stem Test. Kif classification of the drilling fluid components are also indicated.*

Product name	Function	Total Discharged	Klif Environmental classification
Cement cuttings		50-60 m <sup>3</sup>	
<b>WBM chemicals</b>			
Barite	Weighting material	667 MT	Green
Bentonite	Viscosifier	233	Green
Soda ash	pH control	1	Green
Caustic soda	Alkalinity	1	Yellow
<b>NaCl Brine</b>			
Na Cl	Brine/Base Fluid	475	Yellow
Mono Ethylene Glycol (MEG)	Hydrate inhibitor	247	Green
BARACOR 100	Corrosion inhibitor	12	Yellow
STARCIDE	Biocide	1.5	Yellow
OXYGON	Oxygen Scavenger	1.5	Yellow
<b>Clean Up Pill Spacer</b>			
BARCLEAN DUAL	Surfactant for Clean Up	16	Yellow
BARAZAN D	Viscosifier	2	Yellow
Barite	Weighing agent	20	Green
Caustic soda	Alkalinity Source	1.5	Yellow

**Amounts and impacts of emissions to air during DST of Zafarani 2**

The estimated emissions to air during drill stem testing at Zafarani 2 are shown in Table 7-27. The bulk of emissions are CO<sub>2</sub> which correspond to (Cf. Table 7-19):

- › 0.3 % of the annual emission from Tanzania;
- › 0.002 % of the annual emission from Africa and
- › 0.00008 % of the annual emission from the world

This can be considered an insignificant impact.

Table 7-27 Estimated emissions to air during two drill stems tests at Zafarani 2.

	Natural gas	Condensate	Baseoil	Diesel	Total
Amount incinerated (MT)	9,265	231	39	39	9,574
CO <sub>2</sub> emission (MT)	25,506	740	126	125	26,497
NO <sub>x</sub> emission (MT)	131	0.9	0.1	0.1	132.1
CH <sub>4</sub> emission (MT)	2,616	0	0	0	2,616
NM VOC* (MT)	0.65	0.76	0.13	0.13	1.7
SO <sub>x</sub> emission (MT)	0.07	0.78	0.13	0.13	1.1

\*NMVOC=non-methane volatile compounds

**Assessment of impact significance and environmental risk of Drill Stem Test**

Table 7-28 outline the results of the assessment of impact significance and environmental risks of the Drill Stem Test.

Environmental impact significance

It has been assessed that the impacts of the drill stem test are negative, temporary and "insignificant to "minor" or has no impact depending on the environmental feature in question.

Environmental risk

The risks were assessed as "negligible" to "low "for those environmental features that may be affected.

Table 7-28 *Impact of discharge of cement cuttings and drilling fluid and emission to air from flaring of gas during Drill Stem Test.*

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Water quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Benthic fauna	Local	Medium term	Low	Minor impact	Definite	Low risk
Fish	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Birds	No impact	No impact	No impact	No impact	No impact	No impact
Mangroves	No impact	No impact	No impact	No impact	No impact	No impact
Coral reefs	No impact	No impact	No impact	No impact	No impact	No impact
Seagrass	No impact	No impact	No impact	No impact	No impact	No impact
Protected areas	No impact	No impact	No impact	No impact	No impact	No impact
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No impact

#### 7.2.4.8. ACCIDENTAL SPILLS FROM SHIPS OR RISER

Accidental spills from drilling ship and support vessels include:

- › Accidental spills of petroleum hydrocarbons;
- › Accidental spills of drilling mud and
- › Spills due to unplanned riser-disconnect

### Fate and potential effects of spills of petroleum hydrocarbons

Supply vessel may accidentally spill petroleum hydrocarbons into the sea.

Typically, hydrocarbons involved are diesel fuel used for drill-ship engines, as well as other oils and lubricants. Spillage of fuel can result from two operations:

- › **From refuelling of the drill-ship** emanating from ruptures of fuel delivery hoses and/or storage tanks.
- › **From vessel collision** along the navigation route. Vessel collisions may involve fuel supply vessel and the drill-ship or other supply vessels with other vessels along the navigation route to Mtwara Port.

Drilling muds may also be spilled accidentally.

### Fate of oil

Following a spill, diesel or other petroleum hydrocarbons undergoes the following processes: (Table 7-29, Figure 7-13):

- › Spreading;
- › Evaporation;
- › Dispersion;
- › Dissolution;
- › Emulsification;
- › Oxidation;
- › Sedimentation and
- › Biodegradation

The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill whilst oxidation, sedimentation and biodegradation are more important later on and determine the ultimate fate of the oil.

Rate and scale of the different processes are dependent on:

- › The physical and chemical characteristics of the oil;
- › Temperature, wind and currents and
- › Whether the oil is spilled beneath or on the surface of the water

Table 7-29 Processes that affects surface oil spills.

<p><b>Spreading.</b> On the sea surface the oil will initially be distributed as a very thin layer over a relatively large area as a single slick due to the weight of the oil. The slick will quickly be spread by wind and currents in narrow bands parallel to the wind and current direction and will cover extensive areas of the sea surface. The oil slick may be broken up into several separate oil slicks because of winds, wave action and water turbulence.</p>
<p><b>Evaporation.</b> The volatile components of the oil will evaporate to the atmosphere within a short period of time. The rate of evaporation is dependent on temperature, atmospheric pressure and the surface area of the oil film, the rate increasing with increasing temperature, decreasing atmospheric pressure and increasing surface area.</p>
<p><b>Dispersion.</b> Waves and turbulence can break all or part of the oil slick into fragments and droplets of varying size that will be mixed into the upper layers of the water column. Some of the smaller droplets will remain suspended in the water column while the larger ones will tend to rise back to the surface, where they may either coalesce with other droplets to reform a slick or spread out to form a very thin film.</p>
<p><b>Dissolution.</b> The lighter water soluble components of the oil, such as light aromatic hydrocarbons compounds like benzene and toluene, may dissolve into the surrounding water but most of these components will evaporate</p>
<p><b>Emulsification.</b> Due to wave action sea water droplets may become suspended in the oil, forming water-in oil emulsions (often called chocolate mousse), which is usually very viscous and quite persistent.</p>
<p><b>Oxidation.</b> Hydrocarbons can react chemically with oxygen forming either soluble compounds or persistent tar balls with a solid outer crust surrounding a softer, less weathered interior. Such tar balls, are often found on shorelines</p>
<p><b>Sedimentation.</b> Some heavy refined products or dispersed oil that mix with suspended solids have a higher density than seawater and may sink to the bottom. This process mainly takes place on shallow waters that are often laden with suspended solids providing favourable conditions for sedimentation.</p>
<p><b>Biodegradation.</b> Seawater contains a range of microorganisms that can degrade oil components to water soluble compounds and eventually to carbon dioxide and water. However, some compounds in oil are very resistant to attack and may not degrade.</p>

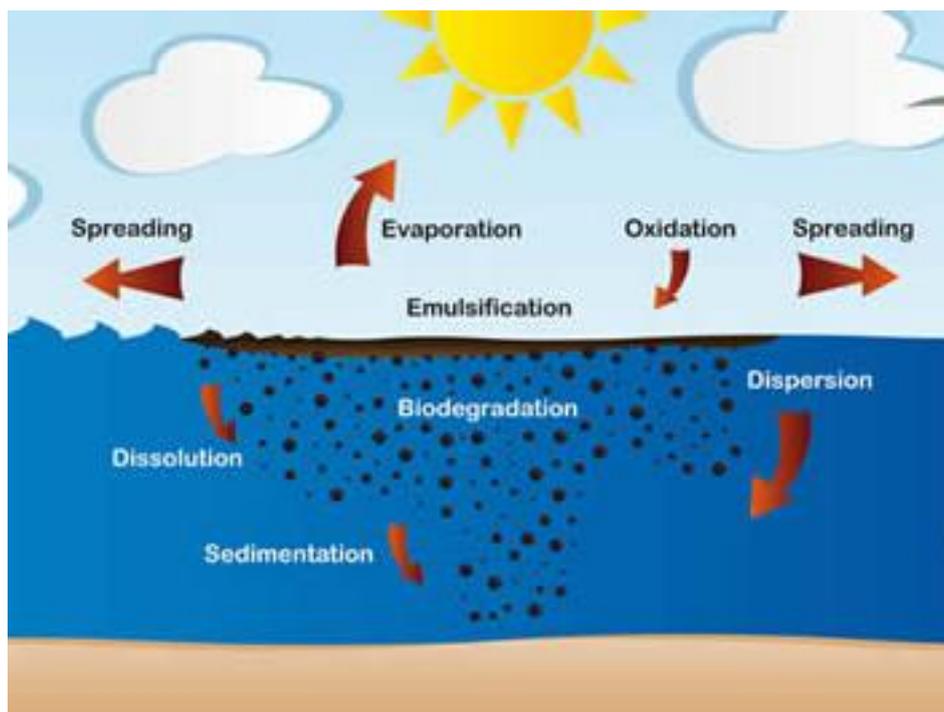


Figure 7-13 Processes affecting oil spilled at the surface (Source: ITOPF 2002)

Potential biological impacts of oil spill

The sensitivity of different groups of organisms and habitats vary markedly. Table 7-30 gives an overview of the vulnerability of different groups of species and habitats.

In general environmental impacts of oil spill are most severe if the slick of petroleum hydrocarbons reaches shallow coastal waters and the shore or if the slick passes concentrations of seabirds which are particularly sensitive to oil spills

Block 2 is situated in an area without any large concentrations of birds that may be affected by an oil spill. If whales, dolphins or turtles are present at the time of the spill they may be affected. However, a spill would only last on site for a relatively short period at concentrations that could affect marine life and is therefore unlikely to significantly affect populations of fauna occurring in the immediate vicinity of the drilling site.

Table 7-30 Overview of potential impacts of oil spills on different groups of organism and habitats

<b>Potential impacts in open waters.</b>
<p><b>Impacts on plankton.</b> Plankton populations are not particularly vulnerable to oil spills. There are no examples of long term effects on phyto - or zooplankton although laboratory studies have demonstrated acute toxic and sub lethal effects of certain oil components on plankton organisms (Falk Petersen et al. 1982, Kühnholt 1977). A few field studies have also demonstrated short term impacts on plankton following an oil spill (Khalaf 2006, Anon 1985). The fact that long term effects have not been observed on plankton populations despite the toxicity of oil is probably due to the enormous regeneration capacity of plankton and the possibility of transport by the current of plankton in to an affected area from adjacent unaffected areas (Anon 1985, Varelaa et al 2006, Kennington &amp; Rowlands 2004).</p>
<p><b>Impacts on pelagic fish, fish eggs and fish larvae.</b> There is no evidence to date that any oil spill in open offshore waters has affected the size of fish populations. Laboratory experiments have shown that oil is very toxic to fish eggs and larvae (Falk-Petersen &amp; Kjorsvik 1987, Serigstad &amp; Adoff 1985, Tilseth, Solberg &amp; Westrheim 1984). However in several studies effects on pelagic fish eggs and larvae were not observed in the field following oil spills. One reason for this may be that toxic concentrations of oil components are generally confined to the uppermost parts of the water column immediately beneath an oil slick and that fish eggs and larvae are encountered below the toxic water layers. Other studies have demonstrated massive kills of fish eggs and larvae in the vicinity of oil spills without causing any effect on fish populations. The lack of effects on numbers in subsequent adult populations following massive kills of eggs and larvae is probably due to the fact that most fish species produce vast numbers of eggs and larvae and because most species have extensive spawning grounds (IPIECA 2000a). Impacts on adult offshore pelagic fish have not been demonstrated. Fish eggs or larvae are not considered particularly sensitive to oil. This is because they do not surface. Hence contact with floating oil is usually minimal (see Neff, 1991), certainly compared to seabirds, marine mammals and turtles. Hydrocarbon levels that effect fish are considerably higher than levels contained in surface oil slicks (see Volkman et al., 1994).</p>
<p><b>Impacts on seabirds.</b> In open waters it is mainly seabirds that are threatened by oil spills. It is well-documented that seabirds are extremely vulnerable to oil spills and that large amounts of seabirds are often killed in connection with an oil spill in areas where seabirds are concentrated. The reason for seabirds being especially vulnerable is that they are often in contact with surface water and that the oil destroys the buoyancy and the isolating quality of the plumage. It is mainly seabirds that stay on the sea surface for longer periods that are at risk, but all types of seabird may be affected (Garcia 2003, Peterson et al 2003, Exxon Valdez Oil Spill Trustee Council 1994, Jonesa et al 1978, Burger 1993)</p>
<p><b>Impacts on whales and dolphins.</b> Whales and dolphins are less vulnerable than birds, but they may be affected due to evaporation of volatile toxic components from the oils slick on the sea surface. If they emerge at the surface to breathe in the middle of an oil slick they may inhale toxic vapours. Exposure to toxic petroleum hydrocarbon fumes may irritate eyes and lungs, cause drowsiness, impairs coordination or breathing which in turn may bring about drowning (Hammond et al 2004).</p>
<b>Potential impacts on shallow coastal waters and shoreline.</b>
<p><b>Impacts on mangroves.</b> Mangroves are well known for being particularly sensitive to oil spills. Mangroves typically grow in more or less anaerobic sediments. They receive oxygen through aerial roots protruding from the sediment surface. There are pores on the aerial roots through which oxygen passes. This root system makes mangroves highly susceptible to oiling. Oil slicks may enter mangroves when the tide is high and are deposited on the aerial roots and sediment surface as the tide recedes. The pores in the aerial roots become clogged by the oil and if many roots are oiled, the respiratory system collapses and the trees die. Mangroves can also be killed due to toxic effects of oil components, especially low boiling aromatics. The toxicity of oil gradually decreases because the toxic aromatics evaporate. Toxic effects therefore mainly arise from newly spilled oil. Oil easily gets trapped in the mangroves and usually persists for a very long time. The oil is subject to microbial degradation which may be a rather rapid process in aerobic environments. However if the oil is buried within the anaerobic sediments, bio-degradation proceeds very slowly (IPIECA 1993b).</p>

Table 7-30 (cont.)

<b>Potential impacts on shallow coastal waters and shoreline. (continued)</b>
<p><b>Impacts on coral reefs.</b> Coral reefs that are encountered along the coast of Tanzania may be very vulnerable to oil spill. Substantial damage to coral reef has been reported several times following oil spills. Generally oil floats over the reef especially on reefs on deeper waters. However oil components may come in contact with corals in a number of ways: i) Some reefs are exposed to the air during low tides. Oil may come in contact with corals and cause severe damage on such reefs , ii) Waves breaking on the reefs may create droplets of oil that are distributed into the water-column, iii) Weathering processes cause oil to sink and iv) Oil components may dissolve in water to some extent which exposes the corals to potentially toxic compounds (IPIECA 1993a).</p>
<p><b>Impacts on seagrasses.</b> In most cases oil will flow above the sea-grass without causing damage. However, sea-grass beds may be affected if oil is brought in contact with sea-grass as described for corals above (Durako et al. 1993).</p>
<p><b>Impacts on shallow water benthic fauna and demersal fish.</b> Benthic fauna organisms are generally very sensitive to oil spill and elevated concentrations of toxic oil components in the water. There are numerous examples of severe impacts on benthic fauna following oil spills. However, impacts have only been observed on shallow water along the coasts where toxic concentrations may reach the seabed. In general, benthic fauna has a high recovery potential. Recolonisation by most species is quite rapid but the recovery of certain sensitive species may be prolonged (such as species of crustaceans and mussels) (Basque Research 2009, SEEEC 1998, Dyrinda 1996, IPIECA 2000, Kingston, et al 1995, Kingston et al 1997, Dauvin 1998). There are also examples of demersal fish and spawning grounds for fish with demersal eggs on shallow waters have been affected by oil spills (Exxon Valdez Oil Spill Trustee Council 2009, Brown and Carls 1998, Peterson et al. 2003, Wright et al 1997)</p>
<p><b>Impacts on nesting sites for turtles.</b> Turtles lay their eggs on sandy beaches. The nests are normally located above the high tide level and the turtles prefer nesting on isolated beaches. Turtles are vulnerable to oil, eggs and juveniles being the most sensitive stages. The hatchlings are especially at risk when they dig their way out of the nest and enter the water. If oil is stranded on a nesting beach the juveniles inevitably have to cross an oiled part of the beach and they become smeared in oil. This may cause skin irritation and surface lesions which may weaken them. In severe cases they may die. During their first period in the sea the young juveniles stay in surface waters and the risk of encounter with oil-slicks is therefore high. Young turtles which have been exposed to oil in water may suffer from a wide number of injuries (disturbed diving and respiratory patterns, decreased blood glucose levels, reddening and sloughing off of the skin and dysfunctioning of the salt glands). These injuries may eventually cause the death of the animal. The eggs are also very vulnerable to oil when buried in the sand. Fresh crude oil on the sand surface, significantly affects the hatching success of eggs. If eggs are exposed to a light dosage of oil mixed in sand, the hatchlings become considerably smaller than normal in terms of weight and size. Fortunately, in case of stranding of oil on the beach, direct oiling of eggs is not likely except during storms because the eggs are usually laid above the high tide marks (Bjorndal 1981, Bolten and Bjorndal 1996)</p>
<p><b>Impacts on waterfowl and shorebirds.</b> Shorebirds and waterfowl are often concentrated on tidal flats and are very vulnerable to oil spills. Apart from the impacts on plumage described for the offshore birds waterfowl and shorebirds may be affected as a result of toxic effects after the ingestion of oil during preening, ingestion of oiled prey, inhalation of oil fumes or absorption of oil through skin or eggs and indirect effects resulting from destruction of bird habitats or food resources (Evans et al 1993)</p>
<p><b>Impacts on shorelines.</b> Shorelines, more than any other part of the coastal environment, are exposed to the effects of floating oil. Oil stranded on beaches often gives rise to grave concern because it may affect a number of ecological and social conditions. Further the cleaning of oiled beaches may be costly. The vulnerability of shorelines differs considerably with respect to how easy they are to clean up after an oil spill.</p>

### Assessment of impact significance and environmental risk of major spills during the operation phase

A major spill of diesel, oil based mud or water based mud could occur if a supply vessel was involved in a collision. However, the probability of a major accidental spill of this kind is very low. Statoil 2011c, estimated the probability of a single vessel accident at  $1.29 \times 10^{-4}$  per drilled well.

The following three scenarios have been evaluated:

- › Accidental spill of 900 m<sup>3</sup> diesel;
- › Accidental spill of 300 m<sup>3</sup> Oil Based Mud and
- › Accidental spill of 300 m<sup>3</sup> Water Based Mud / Chemicals

The evaluation is modified from Statoil 2011c in which a different assessment method was used compared to this report. The modification was done in order to be comparable to the evaluations of other impacts in this report, but the end result is the same.

#### Major spill of diesel

A major spill of diesel may cause negative, temporary "*moderate*" impacts on certain groups of organisms and ecosystems. However, as the probability of spill is low, the environmental risk will be "*negligible*" to "*low*" for those features that may be affected (Table 7-31).

#### Major spill of drilling mud

A major accidental spill of drilling mud has been assessed to cause negative, temporary "*insignificant*" impacts on those features that may be affected and the environmental risks has been assessed as ranging from "*no risk*" to "*negligible risk*", depending on the environmental feature in question (Table 7-32).

Table 7-31 Impact of accidental spill of 900 m<sup>3</sup> diesel (major spill) from supply vessel during the operation phase.

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Water quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Benthic fauna	No Impact	No Impact	No Impact	No Impact	No impact	No Risk
Fish	Local	Short term	Moderate	Minor impact	Low	Negligible risk
Marine turtles	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Marine mammals	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Birds	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Mangroves	Regional	Medium term	Moderate	Moderate impact	Low	Low risk
Coral reefs	Regional	Medium term	Moderate	Minor impact	Low	Negligible risk
Seagrass	Local	Short term	Moderate	Moderate impact	Low	Low risk
Protected areas	Local	Short term	Moderate	Moderate impact	Low	Low risk
Terrestrial ecosystems	No impact	No Impact	No Impact	No Impact	No Impact	No Risk



## Assessment of impact significance and environmental risk of small spills during the operation phase

Small accidental spills include:

- › Small oil spills;
- › Spills of hydraulic oil and
- › Diesel spills from the drill ship or supply vessels,
- › Spills of oil based drilling fluids and chemicals and water based drilling mud from the drill ship or during transfer from supply vessel.

Overall there is low probability of small accidental spills during supply vessel to *drill ship* transfers because safety measures are installed (pressure valves, tank overfill alarms, etc.) that would stop drilling fluid transfers, thus potential loss volumes would be limited to a few hundred litres.

The following four scenarios have been evaluated:

- › Accidental spills of < 50 m<sup>3</sup> diesel;
- › Accidental spills of < 50 m<sup>3</sup> oil based mud;
- › Accidental spills of < 50 m<sup>3</sup> water based mud/chemicals and
- › Accidental spills of < 25 m<sup>3</sup> hydraulic oil

The impacts of small accidental spills of diesel, drilling mud and hydraulic oil have been assessed to cause "*insignificant*" impacts and the environmental risks are "*negligible*" (Table 7-33).



### *Spills due to unplanned Riser-Disconnect*

A riser-disconnect may result from equipment failure or human error, or from an emergency situation that requires the drill-ship to move off the well location rapidly. Such incidences are unlikely to happen as safety measures are in place. However if it occurs, a riser-disconnect would cause large spill of drilling fluids that could temporarily impair water quality from drilling fluids and affect benthic fauna and habitats.

#### 7.2.4.9. BLOW-OUT

A blow-out is the uncontrolled release of crude oil and/or natural gas from a well after pressure control systems have failed. A drilling blow-out can result from a range of causes. These include loss of well control because of design, equipment and/or human failure. Loss of well control is among the major emergency incidences that would have low probability of occurring but high risk of causing large uncontrolled gas or oil release into the marine environment that could cause wide reaching effects (Statoil 2011).

#### Risk of blow-out

Blow-out is an extremely rare event and extensive preventative/ control measures are implemented to reduce the likelihood of such events.

It has been estimated that the risk of a blowout occurring at the Zafarani 1 well would be in the order  $5.45 \times 10^{-4}$  per well drilled (Statoil 2011 c). The risk for other wells in Block 2 may be slightly different but of the same magnitude.

The severity and extent of environmental impacts of a blow-out in a situation where spill response is not in place differ widely depending on whether the blow out is gas or oil.

- › In case of blow-out of oil, the environmental impacts may be severe and affect mainly birds, marine mammals, fish, coastal ecosystems and commercial activities in large areas if oil spill response measures are not in place
- › In case of blow out of gas in deep waters the effects will be less severe. Studies have shown that the gas will not reach the surface in the event of a gas blow-out from deep water. Toxic effects of the gas on the organisms in the relatively low productive deeper waters will be limited to the offshore areas not very distant from the blow out site and not affect the sensitive ecosystems and economically important coastal areas (Cf. Below).

The wells drilled so far at Block 2 have only proved gas. This applies also for all other offshore wells drilled in Tanzania. The first well drilled by Statoil (Zafarani 1) could though potentially have oil, and the EIS for the Zafarani-structure thus included an Oil Spill Response Plan. No oil is expected for the coming wells to be drilled in Block 2.

If analysis for any future wells indicates more than 1% probability for finding oil, an OSRP for that well be established including necessary oil spill equipment. In that case, NEMC and SUMATRA will be notified and involved to the degree deemed necessary.

Although the future wells are not expected to include any oil, a general discussion about oil spills from blowout are included in this EIA as the scenario cannot be completely ruled out for prospects on the not yet explored areas as Davie Ridge and West Side.

#### *Gas blow-out*

During the Top Section Drilling, when the riser pipe and BOP has not yet been installed there may be a slight possibility of drilling into in undetected overpressured shallow gas reserve resulting in the escape of gas to the overlying water. Gas blow-out from deeper in the formation when riser and BOP are installed, may also take place, although this is extremely unlikely.

Field studies of simulated gas blow outs in deep water in Norway combined with numerical simulation model studies has shown that gas rising from deep-sea areas has a different fate and effect than gas escaping from shallow water. During shallow water gas-blow out, the gas will bubble to the surface and cause serious safety risks to personnel on the *drill ship* or drilling rig due to risk of fire and explosion and toxic hazards to personnel. In addition, release of significant amounts of gas to the atmosphere will take place.

Behaviour of  
escaped gas

The Norwegian study and numerical simulations clearly demonstrated that gas escaping from deep water will not reach the surface and that all gas will be transformed or dissolved into the ambient water well beneath the sea surface. This is due to the fact that natural gas is highly dissolvable at the high pressures and low temperatures. In addition, some of the gas may be transformed to gas hydrates which is a slush-like compound made of gas and seawater that do not reach the surface. The mechanism is believed to be as follows. The gas rises as a plume and expands as it rises because of the pressure drop and thus increases the buoyancy. However, the plume gradually loses its momentum and buoyancy due to entrainment of seawater. In deep water, the high pressure and cold temperature causes the possible formation and decomposition of gas hydrates, which reach a neutral buoyancy level beneath the water surface. In the Norwegian experiment natural gas released on 844 m depth 125 km off the coast of Norway did not reach the surface and had disappeared at about 150 m beneath the seasurface (Johansen, Rye and Cooper 2003, Yapa and Chen 2004, Peterson et al 2012).

Effects of escaped  
gas

The dissolved gas and gas hydrates will be spread in the direction of the underwater currents. Most of the gas is methane (CH<sub>4</sub>), which is not toxic as such but methane is readily oxidised to dissolved CO<sub>2</sub> and thereby depletes oxygen very rapidly in water. Organisms in the gas plume may therefore be killed due to anoxia. However, the plume will gradually be oxygenated again from the surrounding water and the sensitive coastal areas will not be affected. Studies on the extent of any impact on marine organisms of deep sea gas blow-out are lacking.

#### *Assessment of impact significance and environmental risk of gas blow-out during the operation phase.*

Environmental  
impact significance

It has been assessed that a gas blow-out during the operation phase may cause negative, temporary "*minor*" to "*moderate impacts*" on those organisms that may be affected.

Environmental risk

As the probability of a gas blow-out is very low the risk has been assessed as "negligible" for organisms that may be affected.

Table 7-34 Impact of gas blow out during the operation phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No Risk
Water quality	Local	Short term	High	Moderate impact	Very low	Negligible risk
Plankton	Local	Short term	High	Moderate impact	Very low	Negligible risk
Benthic fauna	Local	Short term	High	Moderate impact	Very low	Negligible risk
Fish	Local	Short term	High	Moderate impact	Very low	Negligible risk
Marine turtles	Local	Short term	Low	Minor impact	Very low	Negligible risk
Marine mammals	Local	Short term	Low	Minor impact	Very low	Negligible risk
Birds	No impact	No impact	No impact	No impact	No impact	No Risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No Risk
Coral reefs	No impact	No impact	No impact	No impact	No impact	No Risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No Risk
Protected areas	No impact	No impact	No impact	No impact	No impact	No Risk
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No Risk

*Oil blow-out*

In the unlikely event of a blow-out of oil and in a situation when oil-spill response measures are not in place, the environmental impacts may be severe and affect mainly birds, marine mammals, fish, coastal ecosystems and commercial activities in large areas.

Fate of oil

Recent experience from the Deepwater Horizon (DWH) well blow-out in the Gulf of Mexico has shown that a deep water blow-out of crude oil differ from a blow-out on shallow water in terms of behaviour, fate and exposure pathways (Peterson et al 2012).

In traditional shallow water spills, crude oil rises rapidly to the sea surface and gaseous hydrocarbons escape into the atmosphere with minimal residence time in

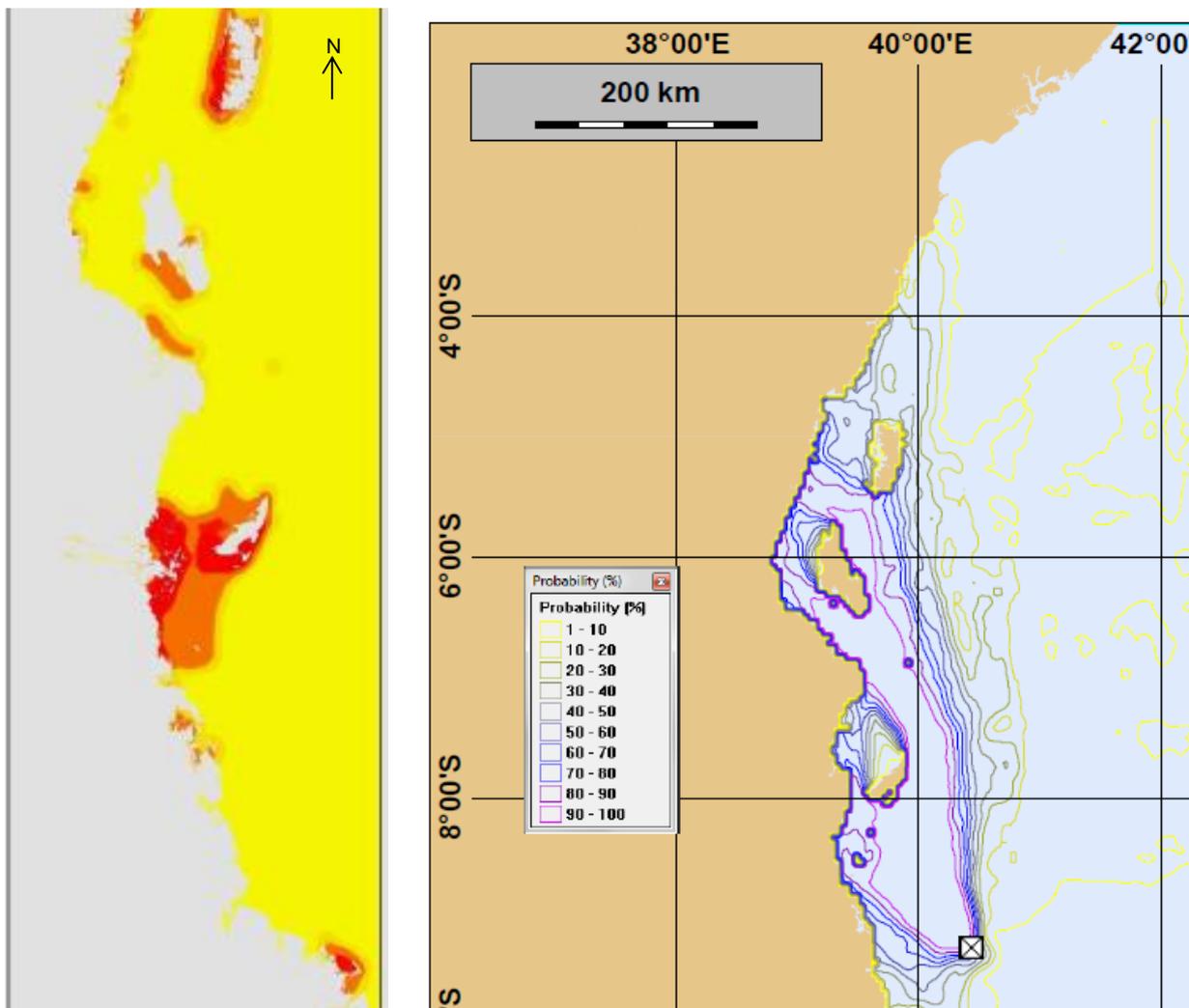
the water column. Organisms that occupy or frequently encounter the sea surface, such as floating seabirds can suffer from high mortality rates. On landfall the surface oil fouls coastal habitats which may cause extensive degradation of ecosystems.

In contrast the DWH blow out which occurred in deep (1500 m) offshore waters off the coast of Mexico, where a highly turbulent discharge of hot, pressurized oil and gas entrained cold seawater under high pressure and produced a variety of dispersed phases, including small oil droplets, gas bubbles, oil-gas emulsions and hydrates. The buoyancy of the oil and gas created a rising plume but due to entrained seawater much of the oil and gas became trapped in deeper waters and was laterally deflected due to the currents. From this deepwater plume water soluble petroleum compounds are dissolved, including most of the methane, ethane, propane and large fractions of water soluble aromatic compounds retaining elevated levels of petroleum hydrocarbons at a water depth of 1100 m possible affecting the deepwater fauna, much of this oil finally ended on the seafloor where it affected benthic deep sea fauna.

It was estimated that half of the oil actually escaped to the surface, but was quite weathered and less cohesive than observed during shallow water blow-outs.

#### Modelling study of oil spill

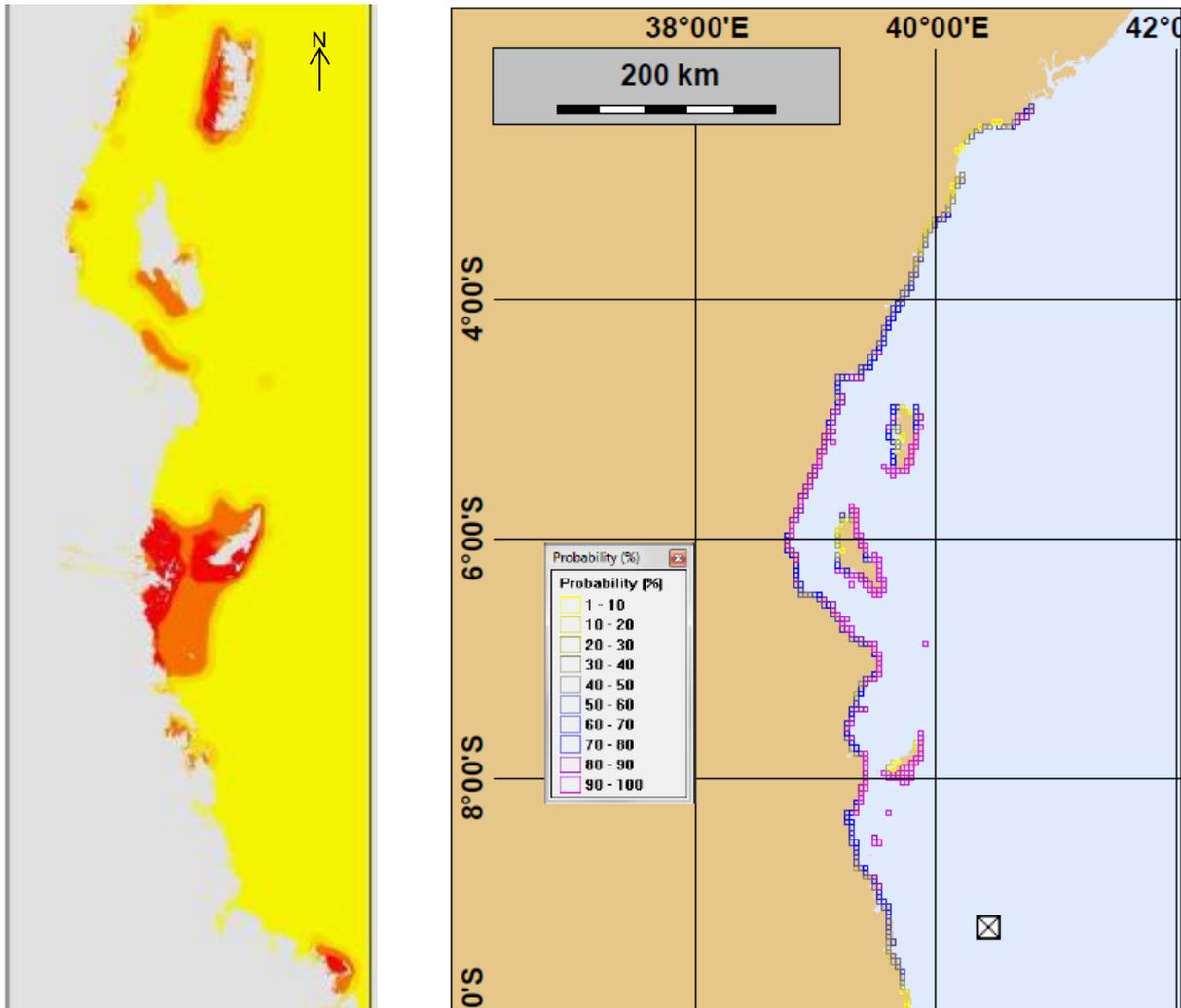
An oil Spill Modelling Study carried out in connection with the Zafarani drilling EIS indicates that hydrocarbons, from oil blow out in the Block 2 area could reach the sensitive Songo Songo Archipelago and Mafia Island shores ca 100 km north of Block 2. This could result in negative impacts to coastal marine ecology and bird life on these shores. However, the overall probability of a major accidental spill of diesel is very low (Statoil 2011a) (Figure 7-14 and Figure 7-15).



Map of biological sensitivity

Modelled percentage probability of contamination being present on the surface at any time over 127 days (above threshold of 0.01 mm) from a subsea oil blow-out and with no mitigating measures in place

*Figure 7-14 Map of biological sensitivity to oil spills compared to the results of a model simulation of a sub-sea blow out in Block 2 showing the probability of oil being present on the surface (without any mitigating measures). For the biological sensitivity map reference is made to section 5.2.5. (Source: TanSEA 2011).*



Map of biological sensitivity

Modelled percentage probability of oil reaching shoreline (above threshold of 0.05 tonnes/km from a subsea oil blow-out if no mitigating measures in place.

*Figure 7-15 Map of biological sensitivity to oil spills compared to the results of a model simulation of a sub-sea blow out in Block 2 showing the probability of oil reaching the shoreline (without any mitigating measures). For the biological sensitivity map reference is made to section 5.2.5. (Source: TanSEA 2011)*

It should be mentioned that the model results may overestimate the amount of oil actually ending up on the coast. The model simulated a traditional shallow water spill and did not take into consideration the new experience from the Deepwater Horizon (DWH) well blow-out in the Gulf of Mexico, where much of the oil became trapped in deeper waters and was laterally deflected due to the currents and where only half of the oil actually escaped to the surface in a quite weathered and less cohesive condition than observed during shallow water blow-out. And the model was run assuming that no oil spill equipment were implemented, which of course is not representative.

*Assessment of impact significance and environmental risk of an oil blow out during the operation phase*

The assessments of impact significance and environmental risk of an unmitigated oil blow out is shown in Table 7-35.

Environmental impact significance

It has been assessed that an oil blow-out during the operation phase may cause negative, temporary "major impacts" on most marine organisms and ecosystems.

Environmental risk

However as the probability of an oil blow-out is very low the risk has been assessed as "negligible" to "low"

Table 7-35 Impact of oil blow -out during the operation phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Minor impact	Very low	Negligible risk
Water quality	National	Short term	High	Major impact	Very low	Low risk
Plankton	National	Short term	Moderate	Moderate impact	Very low	Negligible risk
Benthic fauna	National	Long term	High	Major impact	Very low	Low risk
Fish	National	Long term	High	Major impact	Very low	Low risk
Marine turtles	National	Long term	High	Major impact	Very low	Low risk
Marine mammals	National	Long term	High	Major impact	Very low	Low risk
Birds	National	Long term	High	Major impact	Very low	Low risk
Mangroves	National	Long term	High	Major impact	Very low	Low risk
Coral reefs	National	Long term	High	Major impact	Very low	Low risk
Seagrass	National	Long term	High	Major impact	Very low	Low risk
Protected areas	National	Long term	High	Major impact	Very low	Low risk
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No Risk

## 7.2.5 Impacts during the decommissioning/demobilization phase

### 7.2.5.1. POTENTIAL IMPACTS

The decommissioning phase includes the following main operations:

- › Logging and possible coring of well
- › Plugging of well
- › Demobilization of ships

During the demobilization phase the following potential impacts may occur (Cf. Figure 7-16):

- › Effects of noise from drill ship and supply vessels that may potentially disturb marine organisms such as fish, marine mammals, turtles and sea birds
- › Air emissions and waste generation
- › Effects of accidental spills that may potentially affect marine organisms such as sea- and coastal birds, turtles, marine mammals, fish, coastal ecosystems and fisheries.

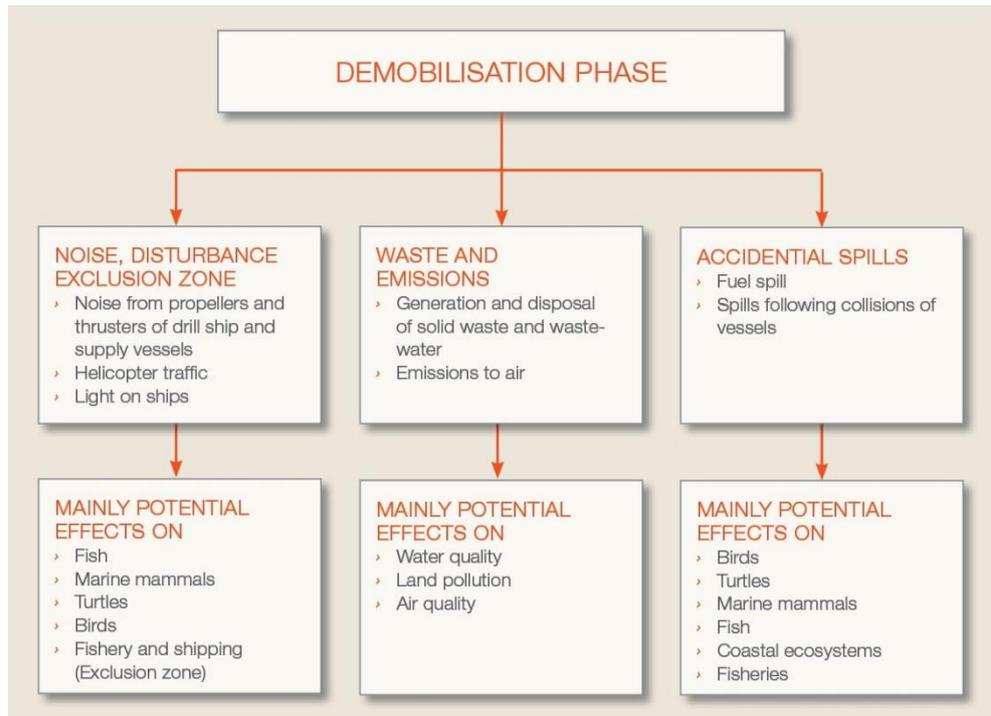


Figure 7-16 Overview of operations during the demobilization phase that may have an impact on the environment and organisms that may primarily be affected by the different operations that has been assessed in the EIS (Source: COWI).

### 7.2.5.2 EFFECTS OF NOISE FROM DRILL SHIP, SUPPLY VESSELS AND HELICOPTERS

Potential environmental impacts of noise are described in section 7.2.4.6 above.

#### Assessment of impact significance and environmental risk of noise during the decommissioning phase

The results of the assessment of impact significance and risk assessment of noise during the decommissioning phase are shown in Table 7-36.

Environmental impact significance

It has been assessed that the impacts of noise during the mobilization phase is negative, temporary and "insignificant" or has no impact depending on the environmental feature in question.

Environmental risk

The environmental risks range from "no risk" to "negligible risk"

The arguments for these assessments are given in section 7.2.4.6 for the operations phase.

Table 7-36 Impact of noise from drill ship, supply vessel and helicopters during the decommissioning phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No risk
Water quality	No impact	No impact	No impact	No impact	No impact	No risk
Plankton	No impact	No impact	No impact	No impact	No impact	No risk
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No risk
Fish	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Birds	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No impact
Coral Reefs	No impact	No impact	No impact	No impact	No impact	No risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No impact
Protected areas	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Terrestrial ecosystems	Local	Short term	Low	Insignificant impact	Definite	Negligible risk

### 7.2.5.3. WASTE AND EMISSION TO THE AIR

Waste and emissions to air are described in section 7.2.4.4 and 7.2.4.5 above

Assessment of impact significance and environmental risk of waste generation and emission to the air during the decommissioning phase

The assessment of environmental significance and risk for waste generation and emissions to the air during the decommissioning phase is shown in Table 7-37. The rationale for these classifications is given in section 7.2.4.4 and 7.2.4.5 for the operations phase.

Environmental  
impact significance

It has been assessed that the impacts of waste generation and emissions to air during the mobilization phase is negative, temporary and "*insignificant*" or has no impact depending on the environmental feature in question.

Environmental risk

The environmental risks range from "*no risk*" to "*negligible risk*"

Table 7-37 Impact of waste and emission to the air during the decommissioning phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Water quality	Local	Short term	Low	Insignificant impact	Definite	Negligible risk
Plankton	No impact	No impact	No impact	No impact	No impact	No Risk
Benthic fauna	No impact	No impact	No impact	No impact	No impact	No Risk
Fish	No impact	No impact	No impact	No impact	No impact	No Risk
Marine turtles	No impact	No impact	No impact	No impact	No impact	No Risk
Marine mammals	No impact	No impact	No impact	No impact	No impact	No Risk
Birds	No impact	No impact	No impact	No impact	No impact	No Risk
Mangroves	No impact	No impact	No impact	No impact	No impact	No Risk
Coral Reefs	No impact	No impact	No impact	No impact	No impact	No Risk
Seagrass	No impact	No impact	No impact	No impact	No impact	No Risk
Protected areas	No impact	No impact	No impact	No impact	No impact	No Risk
Terrestrial ecosystems	Local	Short term	Low	Insignificant impact	Definite	Negligible risk

#### 7.2.5.4. EFFECTS OF ACCIDENTAL SPILLS

During the decommissioning phase major spill of diesel may occur due to ships collisions. In addition small accidental spills of diesel and hydraulic oil may take place. Potential Environmental Impacts of such spills are described in section 7.2.3.8 above

#### Assessment of impact significance and environmental risk of accidental spills during the decommissioning phase

The assessments of impact significance and environmental risk of accidental spills during the decommissioning phase is shown in Table 7-38 and Table 7-39. The arguments for these classifications are given in section 7.2.4.8 for the operations (drilling) phase.

Major spill of diesel	A major spill of diesel may cause negative, temporary and " <i>moderate</i> " impacts on certain groups of organisms and ecosystems. However, as the probability of spill is low, the environmental risk will be " <i>negligible</i> " to " <i>low</i> " for those features that may be affected (Table 7-38).
Impacts of small accidental spills	The impacts of small accidental spills of diesel, drilling mud and hydraulic oil has been assessed to cause negative, temporary and " <i>insignificant</i> " impacts and the environmental risks are " <i>negligible</i> " (Table 7-39).

Table 7-38 *Impact of accidental spill of 900 m<sup>3</sup> diesel (major spill) from supply vessel during the decommissioning phase (oil spill response measures not taken into account).*

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Water quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Benthic fauna	No Impact	No Impact	No Impact	No Impact	No impact	No Risk
Fish	Local	Short term	Moderate	Minor impact	Low	Negligible risk
Marine turtles	Regional	Medium term	Moderate	Moderate impact	Low	Minor risk
Marine mammals	Regional	Medium term	Moderate	Moderate impact	Low	Minor risk
Birds	Regional	Medium term	Moderate	Moderate impact	Low	Minor risk
Mangroves	Regional	Medium term	Moderate	Moderate impact	Low	Minor risk
Coral reefs	Regional	Medium term	Moderate	Minor impact	Low	Negligible risk
Seagrass	Local	Short term	Moderate	Moderate impact	Low	Minor risk
Protected areas	Local	Short term	Moderate	Moderate impact	Low	Minor risk
Terrestrial ecosystems	No impact	No Impact	No Impact	No Impact	No Impact	No Risk

Table 7-39 Impact of small accidental spills during the decommissioning phase.

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Air quality	No impact	No impact	No impact	No impact	No impact	No risk
Water quality	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Plankton	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Benthic fauna	Local	Medium term	Low	Insignificant impact	Low	Negligible risk
Fish	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Marine turtles	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Marine mammals	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Birds	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Mangroves	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Coral reefs	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Seagrass	Local	Medium term	Low	Insignificant impact	Low	Negligible risk
Protected areas	Local	Short term	Low	Insignificant impact	Low	Negligible risk
Terrestrial ecosystems	No impact	No impact	No impact	No impact	No impact	No risk

## 7.2.6 Cumulative effects

Cumulative effects caused by exploration drilling include the combined effects of exploration drilling plus the effects of other activities in the influence area, including fishing and shipping.

During the drilling campaigns the environment may be affected by:

- › Discharge of cuttings and drilling fluid components;
- › Waste generation;
- › Noise and air emissions from drill ship, supply vessel and helicopters;
- › Accidental spills and
- › Blow-out

### Effects of discharge of cuttings and drilling fluid components

The drilling operations will cause some disruption on benthic fauna through smothering by cuttings and mud components in a tiny area around the well site. Observations at Zafarani and Lavani in the Sea Gap area demonstrated that this impact only extended out to a distance of 30-140 m from the well.

Deep Sea drilling is the only activity in the area than may affect the seabed and the benthic fauna. Long-line fishing or purse seine fishing for tuna in the surface water and shipping are the only other human activities in the area and they do not affect the seabed on 1700-3300 m depth.

### Noise and Disturbance

Noise from the drill ship and supply vessels may cause avoidance reactions among dolphins or whales crossing the area. Noise from shipping and fishing activities going on in Block 2 may already affect whales and dolphins. The incremental sound made by supply boats and the drill ship would not add significantly to existing ambient noise levels in the primary impact area.

### Air Pollution

During drilling, exhaust from engines and power generators on drill ship, supply vessels, support vessels and helicopters will be emitted to the air primarily carbon dioxide (CO<sub>2</sub>), but also small quantities of nitrogen oxides (NO<sub>x</sub>) and other gases.

These emissions will not reach inhabited areas and contribute to cumulative effects of air pollution.

### Garbage and Waste Materials

These will not be discharged and so will not contribute to cumulative impacts.

### Accidental Spills of Oil

The probability of a blowout of oil is extremely low, especially since drilling up to now have proved presence of gas and no oil. Should such a blowout occur, oil may drift to the coastal areas and contribute significantly to cumulative effects on several coastal ecosystems that are already affected by other factors. For example:

- › Corals that are severely impacted by bleaching due to temperature rise during occurrence of El Nino , impacted by dynamite fishing, sedimentation or pollution;
- › Mangroves that are severely affected by overharvesting of firewood, charcoal, timber etc., construction of evaporation ponds for solar salt production and large scale conversion to build ports, urban settlements, industries etc.;
- › Seagrass beds that are impacted by excessive sedimentation from land based activities

### Conclusion cumulative effect

From the above it can be concluded that the project will not contribute to measurable or observable cumulative effects apart from the unlikely event of a blow out or a large accidental spill where spilled oil may significantly contribute to cumulative effects.

## 7.3 Socio-economic impacts

The successful discovery of commercial and viable resources of oil or gas is the most prominent and positive socioeconomic effect of the project which may significantly benefit the national economy and development, particularly for the Mtwara Region and the region where the planned LNG-project will be located. The exploration drilling may also create employment opportunities and demand for goods and services.

However, exploration drilling for hydrocarbons has the potential to cause adverse socio-economic impacts to the receiving area, from planned operations as well as from unplanned events such as accidental spills. Assessment of socio-economic impacts has focused on:

- › Employment opportunities;
- › Opportunities for providing local supplies and services;
- › Impacts on fisheries and shipping due to the drilling operation;
- › Impacts due to collisions and accidental spills, particularly impacts that affect coastal socio-economic activities, particularly coastal tourism, fisheries, seaweed farming, oysters and shrimp culture;
- › Health hazards and safety hazards (injuries, fatalities) to crew, workers and public and

- › Piracy threat.

### 7.3.1 Impacts during the mobilization phase

During mobilization, the main project activities that will result in socio-economic impacts are related to the arrival of the drill ship and supply vessels to Tanzania and the mobilisation of supplies at Mtwara Port Base.

The following potential socio-economic impacts during mobilisation are expected:

- › Employment opportunities
- › Opportunities for provision of local supplies and services
- › Impact on fisheries

#### 7.3.1.1 EMPLOYMENT

During mobilisation various staff may be employed to manage either the additional traffic of supply vessels to make sure that they are loaded and offloaded on schedule; the increase in supplies needed for the new drill ship; or the increase of waste to be generated. This presents an opportunity for qualified Tanzanians to be employed in the industry through the following means:

- › Directly with Statoil to work either at the Mtwara Port Base to help with logistics and HSE monitoring; or as support housekeeping staff if additional accommodation will be required.
- › Indirectly with either with TPA or MUFA as labour for offloading and loading vessels; with the waste management contractor who will be responsible for managing waste from Statoil's vessels; or with the supply vessels contracted by Statoil.

It is anticipated that the staff employed during mobilisation will be kept throughout the drilling phase because they have to receive adequate training to ensure effective operations. Qualified staff may be employed not only from Mtwara but also from other regions in Tanzania. Therefore this is a significant and long term positive impact that needs to be enhanced.

#### 7.3.1.2. USE OF LOCAL SUPPLIES AND SERVICES

During the mobilisation of goods such as food, chemicals and fluids, there is an opportunity for certified Tanzanian suppliers to be used either for the provision of goods or for transportation logistics to the Mtwara Port Base. The purchase of Tanzanian supplies and services will contribute to the economic growth.

Since the drilling campaign in Block 2 will involve more than one additional well, Statoil will require a continuous and long term supply of goods and services from mobilisation to well drilling phase. Therefore the use of certified Tanzanian supplies and services will have a continuous, long term impact on the local economy. This is a significant positive impact that needs to be enhanced.

### 7.3.1.3. IMPACT ON FISHERIES

During the mobilization phase an exclusion zone will be established around the drill ship. This may impact access to fishing areas for deep sea fishing vessels, while the supply vessels may likely disrupt areas close to Mtwara Port where small scale fishers regularly set their fishing gear.

#### Impact on deep sea fisheries

During the mobilization phase an exclusion zone will be established around the drillship. The exclusion zone around the drillship may impact access to fishing areas for deep sea fishing vessels. Currently there are no reports of any conflicts between deep sea fishing vessels and on-going offshore explorations in Block 2. In addition, deep sea fishing vessels are flexible to manoeuvre around the drill ship's exclusive zone. Therefore this is considered as a negligible impact.

#### Impact on coastal fisheries

During mobilization, the supply vessels will travel to Mtwara Port to commence their services. While en route, the supply vessels may likely disrupt fishing areas close to Mtwara Port where small scale fishers regularly set their fishing gear. This is a negligible, short term, local impact during mobilisation.

### 7.3.1.4. LAND REQUIRED FOR ONSHORE ACTIVITIES

Supply vessels will require an onshore base to offload waste from the drill ship for treatment and disposal, and to load supply to deliver to the drill ship. In addition Statoil will require storage space for their supplies and an office space to coordinate logistics. This is currently taking place at the Mtwara Port Base under MUFA.

It is not anticipated that Statoil will require any more land for the additional offshore explorations. Furthermore, consultations revealed that TPA is planning to expand the port facility to accommodate the growing offshore exploration activities. Therefore land acquisition is not going to be an impact.

### 7.3.1.5 Assessment of impact significance and environmental risk on socioeconomic features and issues during the mobilization phase

The assessment of impact significance and environmental risk of impacts on socio-economy during the mobilization phase is shown in Table 7-40. The negative impacts may cause "*insignificant impacts*" and have "*negligible risk*".

Table 7-40 Impacts on socio-economy during the mobilization phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Purchases from local suppliers	-	-	-		Highly probable	Positive impact
Employment	-	-	-		Highly probable	Positive impact
Deep sea fisheries	Local	Short-term	Low	Insignificant impact	Definite	Negligible risk
Coastal fisheries	Local	Short-term	Low	Insignificant impact	Low	Negligible risk
Tourism	Local	Short-term	Low	Insignificant impact	Low	Negligible risk

### 7.3.2 Impacts during the operation (well drilling) phase

#### 7.3.2.1 PLANNED ACTIVITIES

During the well drilling phase, the main planned project activities that will result in socio-economic impacts are related to the:

- › Drilling operation on the drill ship;
- › Disposal of waste at Mtwara;
- › Transport of materials between Mtwara Port and the drill ship by supply vessels and
- › Transport of personnel and goods between Dar es Salaam and the drill ship by helicopter.

#### Health and Safety risks

During well drilling the routine operations on the drill ship, supply vessels and on Mtwara Port Base have an inherent risk on the health and safety of personnel. Some of the health and safety risks relate to the following sources:

- › The use of equipment and machinery that can cause injury to humans.
- › The use of substances hazardous to human health;
- › The handling and hoisting of tools, drill casings or heavy machinery from one point to another;

- › Long working hours in strenuous working postures without adequate time to rest;
- › Inadequate supply of safe water and food stuffs and
- › Unhygienic sanitary services.

The potential effects of the above mentioned sources of health and safety risks are outlined in Table 7-41 below.

Table 7-41 Summary of health and safety risks

Source of health and safety risk	Location			Examples of OHS risks
	Drill ship	Supply vessel	Mtwara Port Base	
The use of equipment and machinery	✓	✓	✓	<ul style="list-style-type: none"> <li>&gt; Lacerations</li> <li>&gt; Injury to eyes or limbs</li> <li>&gt; Electrocutation</li> <li>&gt; Burns</li> <li>&gt; Fire</li> <li>&gt; Disturbance from noise</li> </ul>
The use of substances hazardous to human health	✓	✓	✓	<ul style="list-style-type: none"> <li>&gt; inhalation of hazardous fumes causing respiratory problems</li> <li>&gt; Contact burns that can damage skin</li> <li>&gt; Fire</li> </ul>
The handling and hoisting of tools, drill casings or heavy machinery from one point to another	✓	✓	✓	<ul style="list-style-type: none"> <li>&gt; Falling objects landing on personnel resulting in injury</li> <li>&gt; personnel struck by moving objects</li> </ul>
Long working hours in strenuous working conditions without adequate time to rest	✓	✓	✓	<ul style="list-style-type: none"> <li>&gt; Fatigue</li> <li>&gt; Heat stress and sun burn</li> <li>&gt; Weakened immune increasing susceptibility to diseases</li> </ul>
Inadequate supply of safe water and food stuffs	✓	✓	✓	<ul style="list-style-type: none"> <li>&gt; Weakness, fatigue</li> <li>&gt; Cholera</li> <li>&gt; Diaphorrea</li> </ul>
Unhygienic sanitary services	✓	✓	✓	<ul style="list-style-type: none"> <li>&gt; Cholera</li> <li>&gt; Dysentry</li> </ul>
Inadequate management and awareness of communicable diseases	✓	✓	✓	<ul style="list-style-type: none"> <li>&gt; Malaria</li> <li>&gt; HIV/AIDS</li> <li>&gt; Seasonal Flu</li> <li>&gt; Sexually Transmitted Disease</li> <li>&gt; Tuberculosis</li> </ul>

Source: modified from Statoil 2011;

### Social cohesion and communicable diseases

The presence of foreign workers can pose a risk in terms of social cohesion and health impacts of transferable disease. Communicable diseases pose a significant public health threat worldwide. Diseases of most concern during the project are sexually transmitted diseases (STDs), such as HIV/AIDS.

### Disruption of fisheries

The exclusion zone around the drill ship may impact access to fishing areas for deep sea fishing vessels. During drilling operations, the supply vessels sailing to and from Mtwara Port Base to the drill ship will traverse areas where small scale fishers are located especially as they approach near shore. The most common gear used by small scale fishers off the coast of Mtwara include long-lines, baited traps, drift-nets or gill-nets that may not be very visible especially at night. Therefore supply vessels may unintentionally navigate directly across the fishing gear destroying them.

Small scale fishers depend on their daily catch for food and for income by selling their catch at the market. Destroyed fishing gear results in small catch or no catch at all therefore having a negative impact on the fishers' income. Furthermore, small scale fishers may not have the capital on hand to immediately replace the fishing gear.

There are no statistical reports to indicate whether the magnitude of fishing gear destroyed is high, nor the frequency. As additional drilling will require additional supply vessels, the frequency of destroyed fishing gear will likely increase. However the impact to small scale fishers is local near the Mtwara Port entrance and the magnitude is low because not all fishing nets would be potentially destroyed every day. Therefore this is a low impact on small scale fishery industry.

### Noise disturbance to residents

During the drilling phase noise generated onshore will primarily be from the helicopter transferring staff to and from the drill ship. The helicopter will transfer staff from the drill ship to Dar es Salaam where helicopter landing is at the Julius Nyerere International Airport. Therefore noise from the helicopter will not impact local residents in Mtwara Mikindani. The impact of noise from the helicopter for residents near the airport in Dar es Salaam is negligent compared to the larger aircrafts that land at the airport daily.

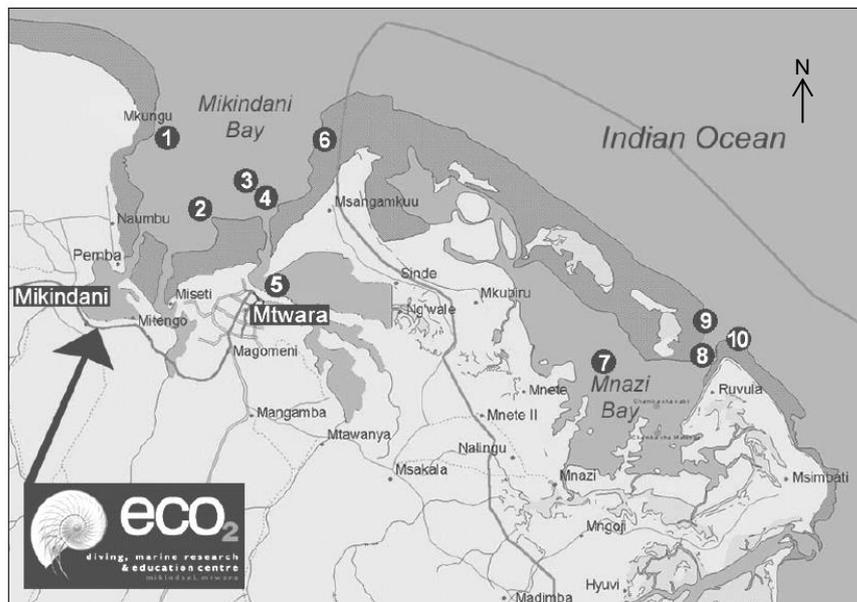
### Impact on nearshore tourism

Near shore tourism activities include diving and sport fishing. Popular diving sites include Pemba Island, Zanzibar, Mafia Island and Mtwara (Cf. Table 5-2). In Mtwara diving sites are found in Mikindani Bay located North West and in Mnazi Bay located south east from Mtwara Port Base respectively (Figure 5-26). Sport fishing is common in nearshore waters of Sinda Island near Dar es Salaam, near Mafia Island, in Mikindani Bay and in Mnazi Bay.

The entrance to Mtwara Port that the supply vessels use includes three SCUBA diving sites utilised by the local diving company ECO2. The sites are called

“Cryptomania”, situated in front of the fish landing site at Shangani, plus two additional sites “Sea Mount” and “Lulu Shoal” located towards the entrance of the seaward passage on approaches to the harbour. The area is however not a popular for sport fishing. (Figure 7-17).

#### SCUBA Dive Sites in Mikindani Bay and MBREMP



#### Mikindani Bay

- 1 - Hulls Rocks
- 2 - The Monoliths
- 3 - Seamount
- 4 - Lulu Shoal
- 5 - Cryptomania
- 6 - Miniliths

#### Mnazi Bay-Ruvuma Estuary Marine Park

- 7 - Coral Garden
- 8 - The Pinnacles
- 9 - Pelagic Corner and Sea Fan Cliff
- 10 - The Buttresses

Figure 7-17 ECO2 dive sites (Source: Statoil 2011b).

Other tourism activities such as sailing on traditional dhows, boat safaris to spot whales or sharks and beach fronts are located near the Mtwara Port Base. However small boats carrying tourists may navigate close to the entrance of Mtwara Port Base. Therefore the presence of supply vessels will not have a direct impact on tourism unless there is an accidental collision between supply vessels and other boats (see section 7.3.2.2 below on socio-economic impacts from unplanned events).

### Assessment of impact significance and environmental risk on socio-economy during the operation phase

The assessment of impact significance and environmental risk of impacts on socio-economy during the operation phase is shown in Table 7-42. Purchase from local supplier and employment opportunities are positive impact. The negative impacts are assessed as causing temporary "insignificant" to "minor impacts" and have "negligible risk"

Table 7-42 Socioeconomic impact of planned operations during the operation phase

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Purchases from local suppliers	-	-	-	Positive impact	Highly probable	Positive impact
Employment	-	-	-	Positive impact	Highly probable	Positive impact
Health and safety	Local	Short-term	Low	Insignificant impact	Low	Negligible risk
Noise disturbance	Local	Short-term	Low	Insignificant impact	Low	Negligible risk
Social cohesion	Local	Short-term	Low	Insignificant impact	Low	Negligible risk
Deep sea fisheries	Local	Short-term	Low	Insignificant impact	Definite	Negligible risk
Coastal fisheries	Local	Short-term	Moderate	Minor impact	Low	Negligible risk
Tourism	Local	Short-term	Low	Minor impact	Low	Negligible risk
Coastal industries	Local	Short-term	Low	Minor impact	Low	Negligible risk

#### 7.3.2.2. IMPACTS FROM UNPLANNED ACTIVITIES/ACCIDENTS

##### Loss from collisions with other marine vessels

While the drill ship and supply vessels travel to Tanzania, they are traversing waters used by deep sea and near shore vessels. In addition during the drilling phase, the supply vessels will be moving to and from Mtwara Port Base and the drill ship frequently. The movement of vessels presents a risk of colliding with either cargo or fishing vessels. No reports of collisions have been identified between vessels involved in offshore drilling activities and cargo or fishing vessels in the last 5 years. Therefore this is an unlikely event.

Should an accidental collision occur between vessels, the main socio-economic effects will include:

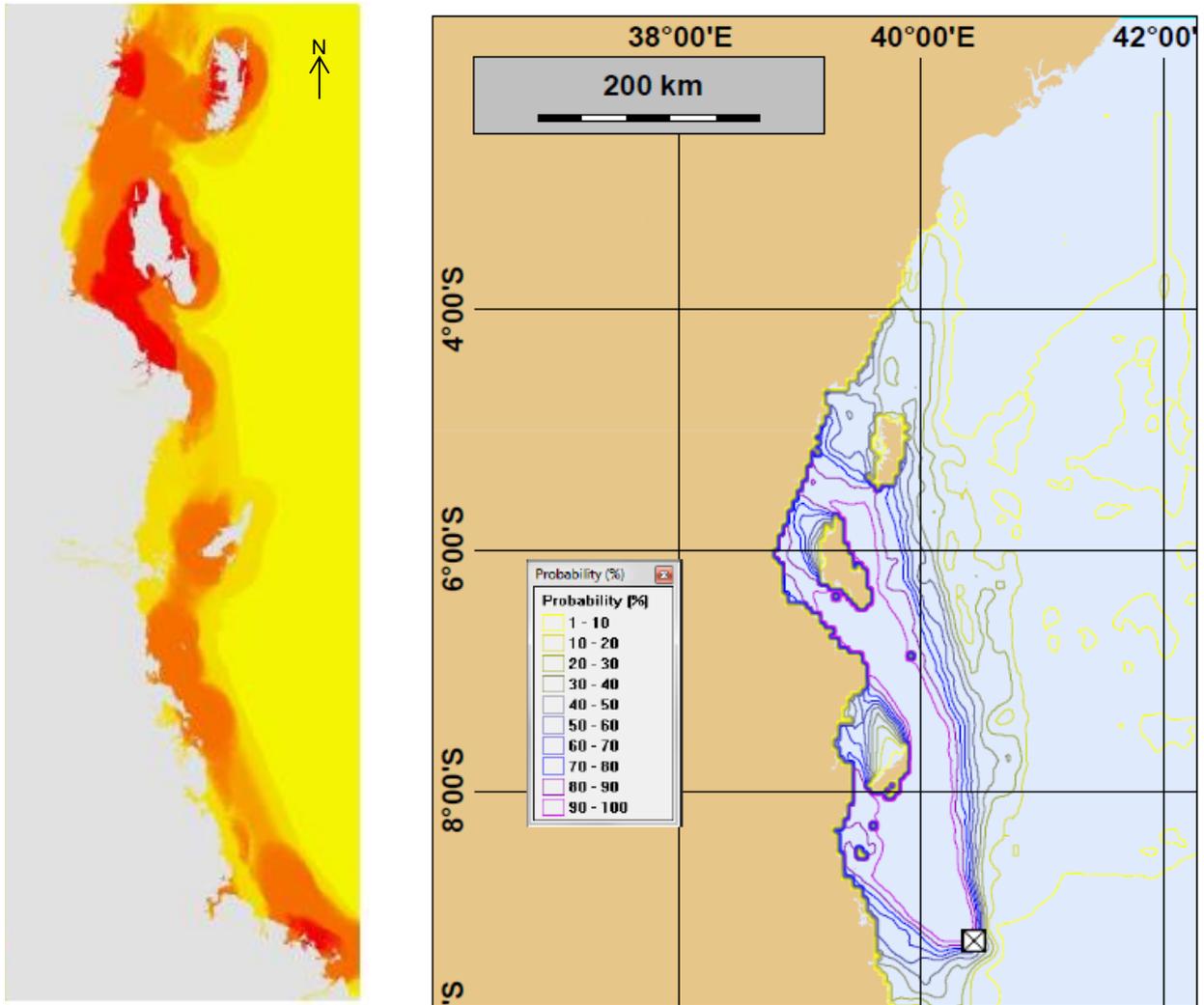
- › The risk of injury or more severe fatalities to crew.
- › The economic cost of operational down time depending the severity of the damage to the vessel(s)
- › The economic cost of any clean up or compensation to employees
- › The economic loss of any cargo, fish catch or supplies depending on the type of vessels that collided.

#### Impact of oil blow out on income generating activities

The oil spill modelling carried out for Zafarani (Statoil 2011a) indicate that parts of the coastal areas towards Mafia Island and Zanzibar may be affected depending on the quantity of oil spilled, the strength of the ocean currents and the response time to abate the spill (Figure 7-18 and Figure 7-19). The following income generating activities along these coastal areas may especially be affected:

- › Fishing and seaweed farming may be negatively impacted either by declined number of fish catch and destroyed seaweeds. Major oil spills may result in loss of fishing opportunities with boats unable or unwilling to fish due to the risk of fouling of boats and fishing gear. Fin-fish and shellfish exposed to crude oil or its products may become tainted and unfit for sale by acquiring oil-derived substances in the tissues which impart unpleasant odours and flavours.
- › Tourism may be affected if certain areas are closed off during clean up. In addition tourists visiting the areas may decline due to perceived uncertainty of safety or pollution in the area.
- › Transportation of goods on cargo vessels from Mombasa, Kenya and Pemba, Mozambique may be affected if the shipping channel is temporarily closed or navigation routes are diverted.

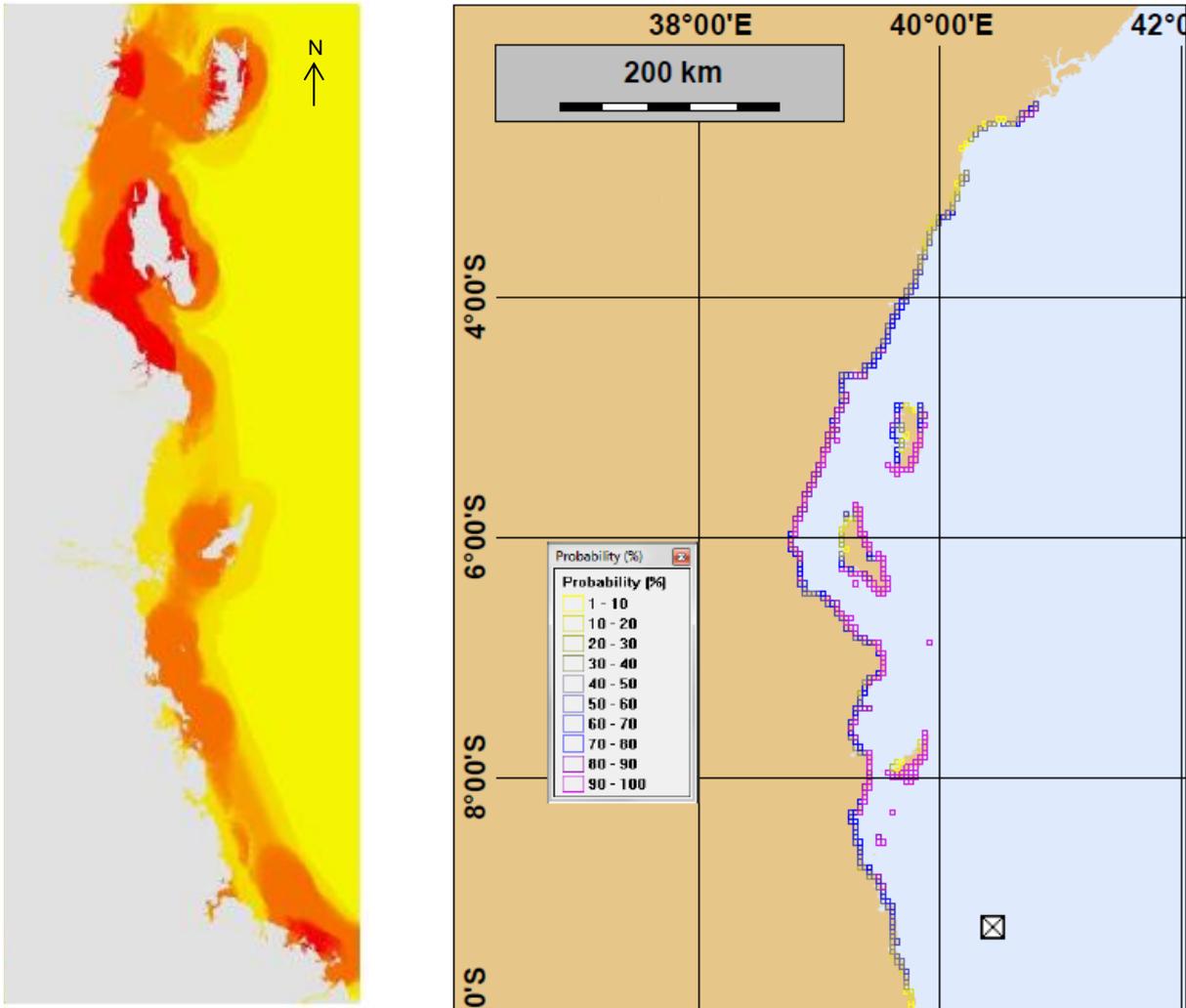
The impact on income generating activities is not expected to be permanent with appropriate restoration and public awareness interventions. It is therefore a major impact because although such an event is severe, the effects are reversible in the long term.



Map of socioeconomic sensitivity

Modelled percentage probability of contamination being present on the surface at any time over 127 days (above threshold of 0.01 mm) from a subsea oil blow-out (without mitigating measures)

Figure 7-18 Map of socio-economic sensitivity to oil spills compared to the results of a model simulation of a sub-sea blow out in Block 2 showing the probability of oil being present on the surface. For the socioeconomic sensitivity map reference is made to section 5.2.5. (Source: TanSEA 2011).



Map of socioeconomic sensitivity

Modelled percentage probability of oil reaching shoreline (above threshold of 0.05 tonnes/km from a subsea oil blow-out without mitigating measures)

*Figure 7-19 Map of socio-economic sensitivity to oil spills compared to the results of a model simulation of a sub-sea blow out in Block 2 showing the probability of oil reaching the shoreline. For the biological sensitivity map reference is made to section 5.2.5. (Source: TanSEA 2011)*

#### Impact of blow out on health and safety

A well blow out can result in injury to crew on the drill ship, security vessel and supply vessel. In severe events fatalities have been known to occur.

#### Piracy

Although there are no recent reports of piracy within the Tanzanian EEZ since the incidents in Blocks 1 and 4 in 2010, this is still a security threat to Statoil's offshore drilling explorations in Block 2. Piracy can directly impact Statoil's operations if it results in damage to vessel or equipment, or injuries and fatalities of crew on vessels. Furthermore, piracy will have indirect economic cost of downtime on operations.

The unlikely event of piracy will result in short term impacts of moderate significance due to the increased security measures taken i.e. each drill ship with their security vessel and national navy patrols.

**Assessment of impact significance and environmental risk of oil blow out on socio-economy**

The assessment of impact significance and environmental risk of oil-blow out on socio-economy is shown in Table 7-43. It assessed that the blow out may cause negative, temporary "major impacts", but as the probability of blow out is low; the risk is "low".

*Table 7-43 Impact of oil blow out during the operations phase (oil spill response measures not taken into account).*

Environmental feature	Extension	Duration	Magnitude	Significance of impact	Probability	Environmental risk
Deep sea fisheries	National	Medium term	High	Major impact	Very low	Low risk
Coastal fisheries	National	Medium term	High	Major impact	Very low	Low risk
Tourism	National	Medium term	High	Major impact	Very low	Low risk
Coastal industries	National	Medium term	High	Major impact	Very low	Low risk

### 7.3.3 Cumulative socio-economic impacts

**In-Migration to Mtwara**

The overall growth of the oil and gas industry , including Statoil's additional offshore activity, will result in the following impacts that need to be addressed and solved by the local government authority (with the support of national ministries) growth of the influx of people will result in:

- › The growing oil and gas industry will need improved waste management facilities in Mtwara, particularly a suitable land fill site to sort, treat and dispose waste effectively. This is an immediate and significant impact to be addressed.
- › The growing number of people and spin off industries will require increased reliable social services: water supply, energy, sanitation and accommodation. Energy from natural gas is already being used in Mtwara. However reliable water supply, sanitation and accommodation will be needed. This is a medium to long term impact.

- › The increased movement of people, goods and information between Mtwara and other parts of the country will require adequate road, railway and telecommunications infrastructure. Roads within Mtwara Mikindani are currently being upgraded, and regional roads connecting Mtwara- Ruvuma Regions and Mtwara-Dar es Salaam Regions are also being upgraded. Based on consultations with TPA in Mtwara, there is also a plan to build a railway to connect Mtwara with Lake Nyasa at Mbamba Bay. This is a medium to long term impact.
- › An increase in income generation in Mtwara either from: direct employment with offshore activities; the growth of certified local service providers based in Mtwara; or the growth of local suppliers of food, machinery, equipment, diesel, etc.

## 7.4 Summary of impacts

### 7.4.1 Environmental impact significance

Table 7-44 and Table 7-45 summarises the results of the assessments of environmental significance of different operations and actions on different environmental and socioeconomic features during the design phase, the mobilization phase, the operation phase and the demobilization phase.

Planned normal operations

The environmental impacts of planned normal operations are negative and temporary. Most impacts are "*insignificant*" and a few are "*minor*".

Unplanned events or accidents

The impacts of unplanned events/accidents may be more severe. The impact analysis has shown that:

- › The potentially most severe impacts are impacts in connection with the unlikely event of a blow out of oil which is assessed potentially to cause negative, temporary "*major impact*" on most environmental and socio-economic features. However, it should be emphasised that the first wells to be drilled are gas wells;
- › Accidental spills of diesel from drill ship or supply vessels may potentially cause "*moderate*" negative, temporary impacts on some marine organisms and ecosystems;
- › Blow-out of gas has been assessed potentially to cause "*moderate*" to major negative, temporary impacts on some marine organisms and ecosystems.

### 7.4.2 Environmental risk

By environmental risk is understood the combination of the significance of an impact and the probability that an impact actually will occur. Some impacts may be major impacts but if the probability that the operations/actions that causes the impact is low, the environmental risk may be negligible

Table 7-46 and Table 7-47 summarises the environmental risks of different operations and actions on different environmental and socioeconomic features during the design phase, the mobilization phase, the operation phase and the demobilization phase.

Planned normal operations

The environmental risks of all planned normal operations are "*negligible*" on environmental features that may be affected.

Unplanned events or accidents

Environmental risks of unplanned events/accidents range from "*negligible risk*" to "*minor risk*" for those features that may be affected. The environmental risk assessment has shown that the potentially largest risk is impacts in connection with the unlikely event of a blow out or large accidental spills of diesel.

Table 7-44 Summary of environmental impact significance of different operations or actions (Ballast water I= For ships arriving from the East African Region This applies for the drilling of the next two wells . Ballast water II= For ships arriving from other parts of the world.

Operations/actions causing the impacts	Environmental features								
	Air quality	Water quality-Plankton	Benthic fauna	Fish	Marine Turtles and mammals	Birds	Mangroves Corals Seagrass	Protected areas	Terrestrial ecosystems
<b>Design phase</b>	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
<b>Mobilization phase</b>									
<b>Planned operations</b>									
Discharge of ballast water I	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Discharge of ballast water II	No impact	Minor impact	Minor impact	Minor impact	Minor impact	Minor impact	Minor impact	Minor impact	No impact
Waste generation and emission to air	Insignificant impact	Insignificant impact	No impact	No impact	No impact	No impact	No impact	No impact	Insignificant impact
Noise, disturbance ,light	No impact	No impact	No impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact	Insignificant impact	Insignificant impact
<b>Unplanned events/accidents</b>									
Major accidental spill of diesel	Insignificant impact	Insignificant impact	No impact	Minor impact	Moderate impact	Moderate impact	Moderate impact	Moderate impact	No impact
Major accidental spill of drilling mud	No impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact	No impact	No impact
Small accidental spills	No impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact
<b>Operation (Well drilling) phase</b>									
<b>Planned operations</b>									
Discharge of cuttings, mud, cement	No impact	Insignificant impact	Minor impact	Insignificant impact	Insignificant impact	No impact	No impact	No impact	No impact
Other planned discharges	No impact	Insignificant impact	No impact	Insignificant impact	Insignificant impact	No impact	No impact	No impact	No impact
Waste generation	Insignificant impact	Insignificant impact	No impact	No impact	No impact	No impact	No impact	No impact	Insignificant impact
Emission to air	Insignificant impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Noise, disturbance light	No impact	No impact	No impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact	Insignificant impact	Insignificant impact
Drill Stem Test	Insignificant impact	Insignificant impact	Minor impact	Insignificant impact	Insignificant impact	No impact	No impact	No impact	No impact
<b>Unplanned events/accidents</b>									
Major accidental spill of diesel	Insignificant	Insignificant	No impact	Minor impact	Moderate	Moderate	Moderate	Moderate	No impact

	impact	impact			impacts	impacts	impact	impact	
Major accidental spill of drilling mud	No impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact	No impact	No impact
Small accidental spills	No impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact
Gas blow out	No impact	Moderate impacts	Moderate impacts	Moderate impacts	Minor impact	No impact	No impact	No impact	No impact
Oil blow-out	Minor impact	Major impact	No impact						
<b>Demobilisation phase</b>									
<b>Planned operations</b>									
Waste generation and emission to air	Insignificant impact	Insignificant impact	No impact	No impact	No impact	No impact	No impact	No impact	Insignificant impact
Noise, disturbance ,light	No impact	No impact	No impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact	Insignificant impact	Insignificant impact
<b>Unplanned events/accidents</b>									
Major accidental spill of diesel	Insignificant impact	Insignificant impact	No impact	Minor impact	Moderate impact	Moderate impact	Moderate impact	Minor impact	No impact
Small accidental spills	No impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact	No impact

Table 7-45 Summary of significance of socioeconomic impacts of different operations or actions

Operations/actions causing the impacts								
	Purchases from local suppliers	Employment	Health and safety	Social cohesion	Deep sea fisheries	Coastal Fisheries	Tourism	Coastal industries
<b>Mobilization phase</b>								
Planned operations	Positive impact	Positive impact	No impact	No impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact
<b>Operation (Well drilling) phase</b>								
Planned operations	Positive impact	Positive impact	Insignificant impact					
Oil blow out	No impact	No impact	-	-	Minor impact	Minor impact	Minor impact	Minor impact
<b>Demobilization phase</b>								
Planned operations			No impact	No impact	Insignificant impact	Insignificant impact	Insignificant impact	Insignificant impact

Table 7-46 Summary of environmental risks of different operations or actions (Ballast water I= For ships arriving from the East African Region This applies for the drilling of the next two wells . Ballast water II= For ships arriving from other parts of the world

Operations/actions causing the impacts	Environmental features								
	Air quality	Water quality-Plankton	Benthic fauna	Fish	Marine Turtles and mammals	Birds	Mangroves Corals Seagrass	Protected areas	Terrestrial ecosystems
<b>Design phase</b>	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk
<b>Mobilization phase</b>									
<b>Planned operations</b>									
Discharge of ballast water I	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk
Discharge of ballast water II	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	No risk
Waste generation and emission to air	Negligible risk	Negligible risk	No risk	No risk	No risk	No risk	No risk	No risk	Negligible risk
Noise, disturbance ,light	No risk	No risk	No risk	Negligible risk	Negligible risk	Negligible risk	No risk	Negligible risk	Negligible risk
<b>Unplanned events/accidents</b>									
Major accidental spill of diesel	Negligible risk	Negligible risk	No risk	Negligible risk	Low risk	Low risk	Low risk	Low risk	No risk
Major accidental spill of drilling mud	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	No risk	No risk	No risk
Small accidental spills	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	No risk
<b>Operation (Well drilling) phase</b>									
<b>Planned operations</b>									
Discharge of cuttings, mud, cement	No risk	Negligible risk	Low risk	Negligible risk	Negligible risk	No risk	No risk	No risk	No risk
Other planned discharges	No risk	Negligible risk	No risk	Negligible risk	Negligible risk	No risk	No risk	No risk	No risk
Waste generation	Negligible risk	Negligible risk	No risk	No risk	No risk	No risk	No risk	No risk	Negligible risk
Emission to air	Negligible risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk	No risk
Noise, disturbance light	No risk	No risk	No risk	Negligible risk	Negligible risk	Negligible risk	No risk	Negligible risk	Negligible risk
Drill Stem Test	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	No risk	No risk	No risk	No risk
<b>Unplanned events/accidents</b>									
Major accidental spill of diesel	Negligible risk	Negligible risk	No risk	Negligible risk	Low risk	Low risk	Low risk	Low risk	No risk
Major accidental spill of drilling mud	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	No risk	No risk	No risk
Small accidental spills	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	No risk
Gas blow out	No risk	Low risk	Low risk	Low risk	Negligible risk	No risk	No risk	No risk	No risk
Oil blow-out	Negligible risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	No risk
<b>Demobilisation phase</b>									
<b>Planned operations</b>									
Waste generation and emission to air	Negligible risk	Negligible risk	No risk	No risk	No risk	No risk	No risk	No risk	Negligible risk
Noise, disturbance ,light	No risk	No risk	No risk	Negligible risk	Negligible risk	Negligible risk	No risk	Negligible risk	Negligible risk
<b>Unplanned events/accidents</b>									
Major accidental spill of diesel	Negligible risk	Negligible risk	No risk	Negligible risk	Low risk	Low risk	Low risk	Low risk	No risk
Small accidental spills	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	No risk

Table 7-47 Summary of socioeconomic risk of different operations or actions

Operations/actions causing the impacts								
	Purchases from local suppliers	Employment	Health and safety	Social cohesion	Deep sea fisheries	Coastal Fisheries	Tourism	Coastal industries
<b>Mobilization phase</b>								
Planned operations	Positive impact	Positive impact	No risk	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk
<b>Operation (Well drilling) phase</b>								
Planned operations	Positive impact	Positive impact	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk
Oil blow out	No risk	No risk	-	-	Low risk	Low risk	Low risk	Low risk
<b>Demobilization phase</b>								
Planned operations			No risk	No risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk

## 8 ENVIRONMENTAL AND SOCIAL MITIGATION MEASURES

### 8.1 Introduction

#### Accidents

The environmental impact significance of impacts of blow-outs and accidental spills of diesel range from "*moderate*" to "*major*" impacts . Mitigating measures for these potential impacts are therefore described in the following.

#### Planned operations

Statoil has been conducting exploration and production well drilling for over 30 years and have well-established procedures and regulations that cover every aspect of the operation. These have been compiled from industry best practice and conform to highest international standards.

The employment of these procedures and regulations is one of the reasons that the planned operations and actions during drilling have been evaluated as causing "*insignificant to minor impacts*" Examples of this are:

- › Statoil's use of low toxic base oil and other low toxic chemicals in the drilling fluids;
- › The application of an efficient cuttings cleaning system onboard the drill ship that treats the cuttings during drilling with SOBM so that the oil content of the discharged cutting is limited to < 6.9% (usually 3-5 %);
- › Statoil's Policy of not discharging remaining SOBM-fluid to the marine environment after drilling is completed;
- › The implemented HSE Policy on all Statoil operations and service providers;
- › Statoil's efficient management of all chemicals used during the drilling operations and
- › Statoil's close follow up of the contractors Waste Management Plan and the updated waste treatment facilities at the Mdenga site. (This plan is outlined in section 8.2.6. below)

Close management is required to maintain the levels of impacts as "*insignificant to minor*". Therefore mitigating measures for some of these impacts are described (cf. below).

## 8.2 Mitigation measures for environmental impacts

This section describes the following mitigating measures:

- › Mitigating measures for accidental spills;
- › Mitigating measures for blow-out of oil;
- › Mitigating measures for the risk of introduction of invasive species via ballast water;
- › Slop treatment;
- › Mitigating measures for the discharge of cuttings with adhered SOBM components and
- › Waste Management Plan.

### 8.2.1 Mitigating measures for accidental spills from ships

#### 8.2.1.1. PROJECT PHASES WHEN MEASURES ARE IMPLEMENTED

The mitigating measures for accidental spills from ships will be implemented during the following phases:

- › The mobilization phase;
- › The operation (well drilling) phase and
- › The decommissioning phase

#### 8.2.1.2. MEASURES

The following measures to combat accidental oil or diesel spills from ships in connection with the drilling of Mronge in Block 2 are in place:

- › The two supply vessels both with offshore oil spill response systems onboard;
- › Dedicated prevention and response measures in the ERP regarding accidental spills for drill ship and supply vessels and
- › Three shoreline protection systems on Mafia Island Marine Park for core areas

### 8.2.1.3. OIL SPILL COMBAT EQUIPMENT ON SUPPLY VESSELS

The two supply vessels will be equipped with oil spill combat equipment including;

- › Oil detection radar systems to allow 24 hour operations;
- › Booms to contain spilled oil;
- › Skimmers to pump up the contained oil and
- › Equipment for spraying dispersants on spilled oil as an alternative response strategy to recovery, which in the event of a major spill may be the most suitable primary response

In addition a temporary storage capability of 1143 m<sup>3</sup> on each vessel will be available.

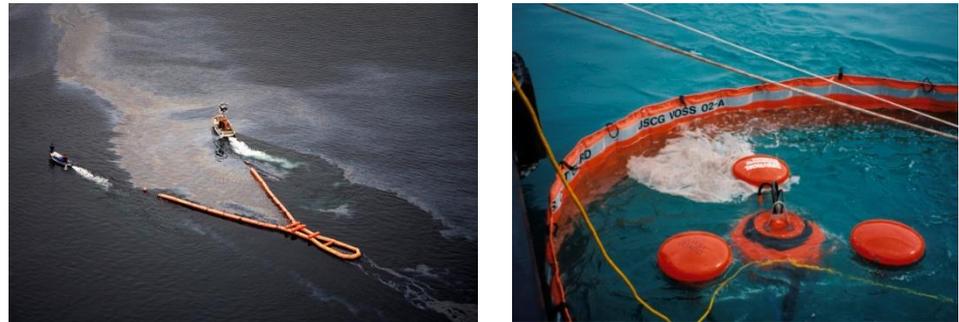
Although not deemed necessary for drilling gas wells in Tanzania, these vessels are equipped with booms and skimmers (offshore oil systems) since they are arriving from a drilling operation in Mozambique where it is required due to the chance of finding oil and the proximity to shore. Other supply vessels will not necessarily be equipped like this if not drilling oil wells.

#### Booms

Following an oil spill so called booms are placed around the spill. The function of the booms are to contain oil spills on the sea surface to control the spread of oil as well as to concentrate oil in thicker surface layers, making recovery easier. The boom systems that are installed on the supply vessels are the so called NOFI Current Buster 6 (Figure 8-1 A). While a conventional oil boom begins to lose oil at 0.7 to 0.9 knots towing speed the NOFI Current Buster collects and retains oil at towing speeds of up to 4 knots. The system offers excellent area coverage and flexibility in towing speeds due to its compact and light construction which facilitates effective towing between oil spill slicks. At the stern of the NOFI Current Buster, the system includes a combined high capacity flexible separator and temporary storage unit. By means of the separation (settling) technique, the unit contains a thick layer of calm oil, thus providing a skimmer or a pump with almost pure oil, giving excellent recovery rates.

#### Skimmers

The contained oil is pumped into storage tanks using a skimmer that can recover oil from the water's surface (Figure 8-1 B).



A. NOFI Current Buster system collecting spilled oil

B. Skimmer for pumping oil contained within the booms

Figure 8-1 Boom and skimmer for mechanical recovery of spilled oil (Source: NOFI Tromsø A/S)

#### 8.2.1.4. PREVENTION AND RESPONSE MEASURES ONBOARD DRILL SHIP AND SUPPLY VESSELS

Statoil has prepared a document that outlines the dedicated prevention and response measures to be implemented for drill ship and supply vessels which are included in the ERPs. The measures are indicated in Table 8-1.

Table 8-1 Dedicated prevention and response measures for drill ship and supply vessels that Statoil require to be implemented.

Prevention measures
<p>The drill ship and the supply vessel must comply with the following:</p> <ol style="list-style-type: none"> <li>1) International certification and approval by the Tanzanian Authorities</li> <li>2) Good operational conditions and serviced according to a service maintenance plan</li> <li>3) Have OSCP (if drilling oil wells) and Emergency Response Plan (ERP) and for (i) oil and chemical spills ii) fire and explosions, (iii) diesel or bunker fuel spills</li> <li>4) Crews trained for emergency response relative to the cargo they transport and operations they perform</li> <li>5) Maintain contact with the Port Authorities</li> <li>6) Have updated information regarding the weather conditions in the area</li> <li>7) Safety measures such as BOPs are in place.</li> <li>8) Fuel tanks or drums capped, not overfilled, marked with contents, and valves closed between connected fuel tanks.</li> <li>9) Store petroleum products &amp; hazardous substances in adequately labelled approved containers.</li> <li>10) Store petroleum products &amp; hazardous substances in bunded areas where spills can be contained &amp; collected</li> <li>11) Use oil collector trays or drip pans under equipment</li> <li>12) Ensure that pipes and hoses are properly connected, closed and in good condition</li> <li>13) Monitor tank levels throughout the program</li> <li>14) Make available absorbent pads near the area where spills may occur</li> <li>15) Conduct transfer operations during calm weather conditions</li> <li>16) Ensure that transfer hoses are of sufficient length and strength to manoeuvre vessels as sea conditions require</li> <li>17) Only conduct transfer operations during the day, if possible, and hoist the "bravo" flag.</li> <li>18) Transfer under reduced visibility conditions (night or overcast), hoist a red light flag</li> <li>19) Conduct transfer under favourable wind and tide conditions that would carry any spill away from sensitive habitats</li> <li>20) Post warning signals before transfer operations begin</li> </ol>

21) During transfers, maintain effective communication between the supply vessel and the drilling rig and monitor the transfer 22) Implement drilling rig fuel transfer procedure
<b>Response measures</b>
1) Implement response procedures as outlined in the OSRP. 2) Limit the spill at the source to the extent possible and contain or recover the material before it reaches the coastal or marine resources. Clean-up actions are required if hydrocarbons reach shore. 3) Inform the port authorities immediately in the event of any spill or accident that could result in a spill. 4) Report all leaks and spills in accordance with the OSRP/ERP.

#### 8.2.1.5. OIL SPILL COMBAT EQUIPMENT ON MAFIA ISLAND MARINE PARK

Statoil also has three shoreline protection systems stored at Mafia Island Marine Park (MIMP). This equipment can be used for combating oil spills that may threaten the sensitive coastline in Mafia Island Marine Park. The systems consists of

- › Shoreline protection booms and
- › Skimmers to collect the oil contained by the booms (Table 8-2)

The principle of shoreline protection by booms is illustrated in Figure 8-2.

The shoreline protection system is partly trailerised to allow for rapid deployment.

Although not deemed necessary for drilling gas wells, the systems will be located at MIMP as part of a Statoil CSR-project that does include training of the rangers to become national experts in protection of the shoreline. The systems will also provide protection of MIMP for any spills offshore from any vessels.

Table 8-2 Oil spill combat equipment positioned on Mafia Island (Source: Statoil)

Equipment	Units	Picture	Description
Shoreline protection boom	75		75 x 10 m sections of neoprene shore sealing boom (Shore-Guardian) plus released ancillaries
Duplex skimmer	3		Three duplex skimmers are available as part of the package, the skimmers can recover oil at a rate of 15 m <sup>3</sup> / hour. The three skimmers come with power pack and temporary storage

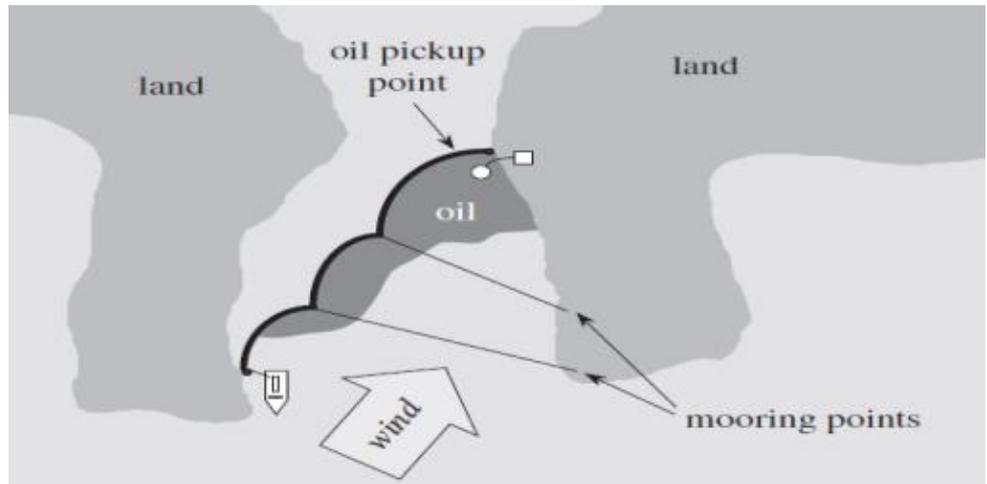


Figure 8-2 Sketch of the way shoreline protection booms are functioning. (Source: Statoil)

## 8.2.2 Mitigating measures for oil blow-out

### 8.2.2.1. PROJECT PHASES WHEN MEASURES ARE IMPLEMENTED

The mitigating measures for oil-blow out will be implemented during the operation (well drilling) phase in case a potential "oil well" is drilled.

### 8.2.2.2. MEASURES

The Emergency Response Plan in place will deal with any minor oil spills and necessary equipment is in place at the base/in the supply vessels (Cf. Section 8.2.1 above). An dedicated Oil Spill Response Plan will be developed if there is a well to be drilled that can contain oil which might lead to an blow out situation (tier 3. The forthcoming wells are all classified as gas wells, and hence no specific OSRP is needed. If future wells will be classified as potential oil wells, the OSRP developed for Zafarani 1 will be updated and additional equipment purchased according to the risk identified.

For each well a specific evaluation of the probability of oil will be made, and the general criteria established if this exceeds 1 %, an Oil Spill Response Plan (OSRP) for that particular well will be needed. There will be a general contingency in place to cope with potential minor spills as fuel, hydraulic oil, oil based mud.

Essential features of the OSRP for Zafarani-1

The OSRP for Zafarani-1 was prepared in accordance with international best practice and Tanzanian legislation.

This OSRP for Zafarani-1 followed the Tiered Preparedness and Response concept. This concept allows potential oil spill incidents to be categorized in terms of their potential severity and the capabilities that need to be in place to respond. Three Tiers was defined:

- › Tier 1 spills are operational in nature occurring at or near an operator's own facilities, as a consequence of its own activities. The individual operator is expected to respond with his own resources.
- › Tier 2 spills are most likely to extend outside the remit of the Tier 1 response area and possibly be larger in size, where additional resources are needed from a variety of potential sources and a broader range of stakeholders may be involved in the response.
- › Tier 3 spills are those that, due to their scale and likelihood to cause major impacts, call for substantial further resources from a range of national and international sources.

Oil spills will be handled by Statoil's Emergency Response Organisation (ERO) in Tanzania. This ERO has Line 1 on the scene and Line 2 in Dar and Mtwara. Line 1 on board the actual accidental vessel or another relevant Statoil operated vessel will be the operative oil spill performer supported by Line 2. If possible scenario for the actual well comprises Tier 3 oil spill scenario (high possibility for oil-bearing reservoir) plan for Tier 3 oil spill handling will be established before start of drilling. Tier 3 contractor (Oil Spill Response Ltd) will be part of this plan and as so also part of possible oil spill handling.

The OSRP for Zafarani-1 is found in Appendix 7.2.

### 8.2.3 Mitigating measures for the risk of introduction of invasive species via ballast water

#### 8.2.3.1. PROJECT PHASES WHEN MEASURES ARE IMPLEMENTED

The mitigating measures for the risk of introduction of invasive species via ballast water will be implemented during the mobilization phase if relevant.

#### 8.2.3.2. BACKGROUND

The discharge of ballast water from a ship arriving to Tanzanian waters from other parts of the world may cause the introduction of alien invasive species that can alter the structure and biodiversity of ecosystems in the area. For the first drillings in Block 2 there is no risk of introducing invasive species as the vessel will arrive from Mozambique with a marine ecosystem similar to that in Tanzania. For future, yet unplanned, operations in Block 2, another drill ships may potentially arrive from other parts of the world and thus represent a risk of introducing invasive species.

However, the risk of introducing invasive species via ballast water is mitigated, by a mandatory Ballast Water Management Plan. This is only applied for vessels arriving from outside East African Waters.

### 8.2.3.3. Ballast Water Management Plan

The following mitigating measures in terms of reducing risk of the introduction of invasive species via ballast water will be included in the Ballast Water Management Plan

- › Using precautionary practices during intake of ballast water including
  - › Avoiding unnecessary discharge of ballast water;
  - › Minimizing the uptake of harmful aquatic organisms, pathogens and sediments avoiding loading of ballast water in areas and situations such as:
    - › In areas identified by the port State in connection with advice provided by ports such as i) areas with outbreaks, infestations or known populations of harmful organisms and pathogens, ii) areas with current phytoplankton blooms (algal blooms, such as red tides), iii) nearby sewage outfalls, iv) areas where a tidal stream is known to be the more turbid, v) areas where tidal flushing is known to be poor, vi) nearby dredging operations and vii) nearby or in sensitive or estuarine sea areas;
    - › In darkness when organisms may rise up in the water column;
    - › In very shallow water;
    - › Where propellers may stir up sediment; or
    - › Where dredging is or recently has been carried out.
- › Using Ballast Water Exchange (BWE) before arriving at Tanzanian waters: BWE
  - › Ballast water exchange is the process of exchanging coastal water, which may be fresh water, salt water or brackish water, for mid-ocean water. During the exchange process, biologically laden water taken on in the last port of call is flushed out of the ballast tanks with open ocean water, typically 200 nautical miles from the nearest land. Scientific studies have shown that marine organisms and pathogens are, in general, less numerous in the open ocean and, due to changes in the water's chemistry, temperature and salinity would be less likely to survive once they are discharged into the near shore receiving waters.

## 8.2.4 Slop treatment

### 8.2.4.1. PROJECT PHASES WHEN MEASURES ARE IMPLEMENTED

The slop treatment will be carried out during all project phases, but most actively during the operation phase

#### 8.2.4.2. FUNCTION OF SLOP TREATMENT UNIT

The Slop Treatment Unit onboard the drill ship can handle all slop produced from drilling slop to brine/seawater and wash water. The system works as follows:

- › The slop from the drill floor, pit room, mud lab and shaker room is collected in a slop tank;
- › From the slop tank the slop is transferred to vessels where emulsion breaker chemicals are added to remove oil from the slop;
- › From the emulsion breaking process vessels the slop is transferred to a flocculation tank where both particles and oil are separated from the water;
- › The slop is then passed through solid filters as well as hydrocarbon filters and
- › The result is clear water free of particles and oil, acceptable to be discharged to the environment and sludge which is sent to shore.

Before discharge, analysis of the water is required. The water must comply with international standards. Statoil is referring to MARPOL discharge standard (15 ppm hydrocarbons).

### 8.2.5 Mitigating measures for the discharge of cuttings with adhered SOBMs components

#### 8.2.5.1 PROJECT PHASES WHEN MEASURES ARE IMPLEMENTED

The mitigating measures for the discharge of cuttings with adhered SOBMs components will be implemented during the operation phase.

#### 8.2.5.2 MEASURES

The existing solids control system onboard *Discoverer Americas* and other drill ships can treat the cuttings drilled with SOBMs to a hydrocarbon level of < 6.9 % before discharge. Normally the performance will be in the range of 3-5% and recent operations indicate levels of 3-3.5%.

The impact evaluation of the discharge of cuttings demonstrated that the impact of discharging cuttings with this level of attached hydrocarbons will have a "negligible" impact on the environment and model studies carried out in connection with the Zafarani-1 drilling have indicated that the difference in terms of environmental impacts between discharging cuttings with 5% hydrocarbons and 1 % hydrocarbons is marginal (Ditlevsen 2011).

Alternative options to the existing treatment are:

- › Shipping of cuttings to shore, for onshore treatment in a cuttings cleaning plant a so called Thermo mechanical Cuttings Cleaner (TCC) to reach <1% base oil on the cuttings;

- › Shipping of cuttings to shore for drying and disposal without further cleaning;
- › Install a TCC-treatment unit onboard the drill ship and discharge the treated cuttings (ash).

Statoil will initiate studies for evaluating the feasibility of these various options more in detail

#### Option 1. Shipping of cuttings to shore, for onshore treatment in TCC and deposition

The cuttings may be shipped ashore and treated in a so called Thermo mechanical Cuttings Cleaner (TCC) plant (Figure 8-3).

The TCC plant is specially designed for the processing of oil contaminated drilling waste such as typical drill cuttings, slop-mud and spent drilling mud. In the TCC plant the drilling waste is separated into three main components:

- › Mineral solids;
- › Base oil and
- › Water

The principle of a TCC is to heat the waste stream to a temperature that is higher than the evaporation temperature of the base oil. The oil and water then evaporates and are subsequently condensed in separate condensers. In the TCC the waste is heated by friction transforming kinetic energy to heat. The core technology is a drum shaped chamber through which a shaft with a series of hammer arms is mounted (Cf. Figure 8-4). An electrical motor or diesel engine drives the shaft. Prior to start up, sand is fed into the chamber and the shaft is set in motion. The particles are then forced toward the inner wall of the chamber where the end of the hammer arms beat the particles and create frictional heat. When the temperature is high enough, the waste is fed into the chamber. The liquids in the waste evaporate immediately and after a few seconds leave the chamber as vapours, which are condensed in separate tanks for water and oil. New waste is continuously fed in as the temperature rises, while dried cuttings are fed out into the water like an ash. With this technology it is possible to clean cuttings to a level of hydrocarbons of < 1%.



TCC from Thermtech Norway



Onshore TCC installation from a M-I SWACO plant in Kazakhstan

Figure 8-3 Onshore TCC installations (Source: Thermtech A/S)

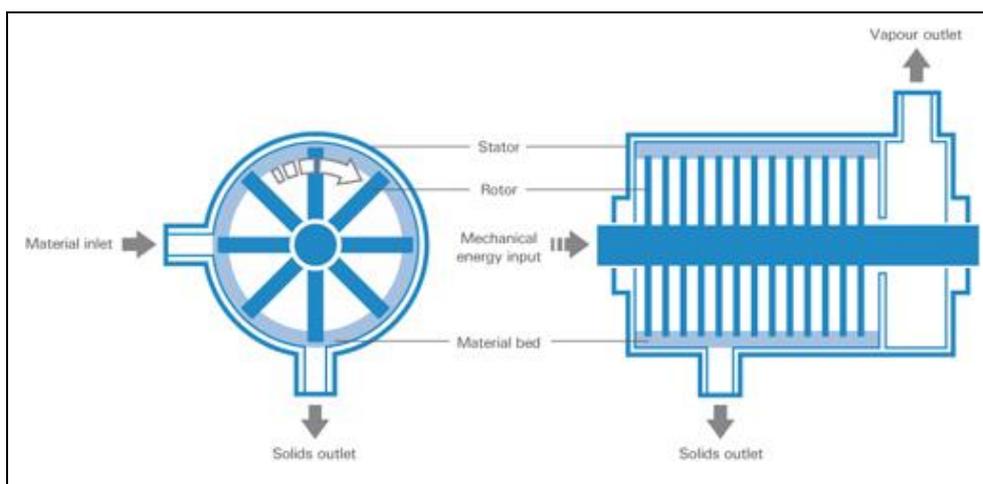


Figure 8-4 Sketch of a TCC unit (Source: Thermtech A/S)

However, this option has many drawbacks:

- › The option require installation of an onshore TCC unit at Mdenga or at another location which will be expensive, take some time to install and will not be in place for the drilling in the near future;
- › Increase the energy consumption significantly as the TCC methodology is very energy demanding and a separate generator will need to be installed at Mdenga or other potential location
- › Cuttings has to be stored in skips onboard prior to transportation, which will occupy valuable space onboard;

- › The extra number of skips that is needed for the operation must be lifted by crane onboard the supply vessels and unloaded at the base in Mtwara, which increase the risk of accidents and accidental spills;
- › The offloading of skips in Mtwara will increase the risk of accident and accidental spills;
- › Demand of truck transport of skips from Mtwara Port to the Mdenga waste management site will increase somewhat, which in turn will:
  - › Increase costs;
  - › Increase the risks of traffic accidents

#### Option 2. Shipping of cuttings to shore, for drying and disposal at cement factory or in Mtwara

The cuttings could also be placed into skip containers and transported to the Mdenga Site or other suitable site where they are laid out to dry in a bunded area before transported to the Tanzania Portland Cement Company factory in Dar es Salaam.

However, this option will require significant transport in trucks from Mtwara to Dar with significant the health and environmental risks associated. In addition, agreement with the cement factory has to be extended to receive higher volumes of cuttings than today. And finally, pits for drying the volumes of cuttings prior to transport have to be constructed, which will need suitable areas.

In total, this option will lead to increased emissions to air, accidental risks due to transport; consume land and significant increased costs.

Regarding sending all SOBMs-cuttings to the cement factory as input to their production, this will as far as we know, not be accepted for other cuttings that those already approved by the factory due to quality control of any input material to the production. If sending all SOBMs-cuttings to the factory will represent volumes estimated to around 200 m<sup>3</sup> rock based cuttings per well compared to the 10-15 m<sup>3</sup> cement based cuttings that has been the case during the previous campaign.

This option with transport and disposal of cuttings to shore is not seen as a recommended nor feasible solution as there are no permanent storage facilities in Mtwara and due to the fact that transport to and disposal of of all cuttings in Dar is not seen as feasible.

#### Option 3. TCC-unit installed at the rig

In this option a Thermo-mechanical Cuttings Cleaning (TCC) system is installed at the drill ship Discoverer Americas for further treatment of the SOBMs cuttings after the initial SCS treatment using the existing system at the drill ship.

This option implies the following operations in addition to the drilling and initial SCS treatment of cuttings at the drill ship:

- › Transfer of SCS treated cuttings to the TCC system by an conveyor system (specific type yet to be decided).
- › Transfer of TCC treated ash/particles to a mixing chamber by conveyor system where it is mixed with the water condensate from the TCC and sea water.
- › Discharge of TCC cuttings slurry to the sea at a few meters depth below sea level.

In this option the residuals of the cuttings will be discharged to sea as slurrified ash. This has caused some concerns in other countries regarding potential negative impacts to marine life. The oil recovered fraction can be reused and the condensed water will be discharged to sea. It is most likely that it will be driven by a diesel engine. Having such a unit onboard introduces a potential health concern regarding the noise. This might be reduced if electrical power can be used as energy source, however this will be a significant modification of the drill ship.

However, installation of a TCC-unit onboard the drill ship will be seen as a modification of the ship work and will need to be done in a ship yard. It will be handled as a modification project and will thus need a certain time for studies of the technical feasibility, HSE-risks and costs

## 8.2.6 Waste Management Plan

### 8.2.6.1. PROJECT PHASES WHEN MEASURES ARE IMPLEMENTED

The waste management plan will be implemented during the following phases:

- › The mobilization phase
- › The operation (well drilling) phase and
- › The decommissioning phase

### 8.2.6.2. MEASURES

The SBS Waste Management Plan includes a range of disposal methods, undertaken in accordance with legislation and standards, Local Government Authority by-laws, and international agreements i.e. Basel Convention (see Chapter 4). The plan is based on the following principles:

- › Segregation of waste streams on board drill ship and supply vessels;
- › Recycling or reuse of waste products where possible;
- › All solid wastes that are returned to Mtwara Port for disposal, as per agreed Municipal procedures and
- › No discharge of solid wastes overboard (except for cuttings).

SBS practice a waste management hierarchy of Reduce, Reuse, Recycle, Treat and Dispose. Wastes from all sites of the both offshore and onshore operations are received and segregated in Mtwara port’s designated area. Recycled waste is currently segregated at Mtwara port according to the categories in Box 1 below.

<b>Box 1</b>				
<b>Recyclable waste segregation colour codes and categorisation</b>				
Plastic	Oily	Metals	General waste	Wood

From Mtwara Port waste is transported to SBS’s Mtwara Waste Management Facility and managed based on three main categories: recyclable, general and hazardous waste.

**Recyclable (Non-Hazardous)**

Recyclables includes empty oil drums, aluminum cans, plastic water bottles, non-treated wood and recyclable scrap metals (steel and tin cans):

Plastic is currently sorted and flattened into bails to be transported to a factory in Dar es Salaam.

Aluminium cans and drums are flattened and to be transported to a licensed smelter in Dar es Salaam.

Glass is crushed and is used by other contractors for example road construction material or glass recyclers.

Metals are transported to a licensed smelter in Dar es Salaam.

Non-treated wood is reused for furniture and building etc. Long term plan is to find a licensed company to recycle.

**General Waste (Non-Hazardous)**

Non-hazardous, inert combustible and biodegradable solid wastes that are not covered under recyclable category. Since an approved landfill is not available in Mtwara, SBS will incinerate combustible and biodegradable solid wastes that include:

- › Inert solids: PVC and vinyl plastics, rubber, used gloves.
- › Inert combustible solids: used paper, newspapers, cardboard
- › Biodegradable food wastes
- › Helicopter fuel and used oil
- › Non- recyclable cans and drums

Ash from the incinerator is to be stored at the facility and transported to Twiga cement factory.

### Hazardous Waste

Waste items that are not suitable for disposal to a general landfill and must be handled in a controlled manner. Hazardous waste shall be strictly controlled, clearly labelled and stored in suitable containers (with correct handling and segregation requirements); and recorded in the shipping manifest when transferring from offshore.

- › Cuttings, if oil content exceeds 6.9%, are to be brought onshore are placed into skip containers and transferred to the Mdenga Site to be laid out to dry in a bunded area. Once dry, they shall be packed in containers and transported to a cement factory in Dar es Salaam.
- › The slop and sludge is to be placed in the slop tanks to settle so that the oil layer on top is skimmed off and will be used in the incinerators. The rest is processed in a recently installed Slop Treatment Unit, called the "Nature Unit" producing treated water and a solid residue that is similar to cuttings. The treated water meeting the TBS standards will be discharged according to the conditions specified by the discharge permits issued by NEMC. SBS received a discharge permit for treated waste water in April 2013. Analytical tests are being carried out on the solid residue and if found acceptable it is recycled at the TWIGA cement factory in Dar es Salaam.
- › A similar unit is installed on the drill ship Discoverer Americas and will treat the slop water to meet the standards set. The recovered oil and the sludge will be transported to Mdenga waste management site. The recent performance has been in the range of 12-13 ppm hydrocarbon which is below the Statoil standard of 29 ppm and b the Marpol/IFC-standard of 15 ppm.
- › Sewage from offices is to be treated in the Ecomax sewage system on Mdenga.
- › Other hazardous waste will be incinerated, including:
  - › Waste engine and cooking oil and oil filters,
  - › Thinners, solvents and grease
  - › Medical waste
  - › Sanitary waste
  - › Fluorescent tubes and metal aerosol cans (pierced before incinerated)

Treated wood is to be burnt in the incinerator until an alternative solution is found. Wood treated with Methyl Bromide is not to be burnt in an open fire for example for cooking. Research indicates that Methyl bromide is corrosive to both the skin and eyes, inhalation exposure is toxic and research results suggest that low-level, chronic exposure to methyl bromide affects the nervous system (General Fact

Sheet- Methyl Bromide, National Pesticide Information Centre  
 npic.orst.edu/factsheets/MBtech.pdf ).

### Waste Management Facility

The current waste management site is to be fenced off to avoid unauthorised entry and to protect the local community from accidents.

With the continuous increase of offshore drilling activities it is recommended that the waste management contractor identifies an alternative site for managing offshore waste in collaboration with the local government authority. This site should be well enclosed from neighbouring residents and with adequate drainage to avoid water stagnation.

## 8.3 Occupational Health and Safety

### 8.3.1 Project phases when measures are implemented

Occupational health and safety measures will be implemented during the following phases:

- › The mobilization phase;
- › The operation (well drilling) phase and
- › The decommissioning phase

### 8.3.2 Measures

Occupational health and safety issues are relevant to those aboard the drill ship and supply vessels, helicopter crew and staff and workers at the Mud Plant and Mtwara Port.

#### HSE Policy

Statoil has a comprehensive Health Safety and Environment (HSE) Policy which is implemented on all their operations and service providers. Statoil’s general aim is zero harm to people (Cf. Appendix 2).

In addition the drilling vessel and supporting vessels will operate to internationally recognized standards, including those of health and safety at sea to minimise risk to personnel, equipment and the environment.

#### Chemical management

Chemicals involved in operating the ship and its activities are under chemical management.

In-house products (catering, engine oils, chemicals for maintenance etc.) are handled by the rig owner. The chemical substances used for the drilling operation is defined as those used for drilling and cementing, dope for drill pipe and casing, BOP-fluids and rig wash. These five product groups are used in areas where

discharge will or may occur, and Statoil will conduct hazard and risk assessment for each product involved. All relevant products will be assessed.

Some of the chemicals and certain lubricants have the potential to cause damage to humans or the environment, and are considered hazardous. All hazardous chemicals are to be accompanied by their corresponding Material Safety Data Sheets (MSDS). All chemicals will be handled, stored and used in strict accordance with laws and regulations of Tanzania and Statoil requirements/guidelines. The MSDS of each product and relevant hazardous materials/waste will be included in the Waste Management Plan.

## 8.4 Mitigation measures for socio-economic impacts

### 8.4.1 Use of local supplies and service

To enhance the positive impacts to be realised the following can be done:

- > Statoil to have a procurement policy that promotes employment of certified Tanzanian service providers and suppliers;
- > TPDC to work with SUMATRA, TBS, Mtwara Mikindani Municipal Council and NEMC to streamline the standards and certificates required for service providers and suppliers to the gas industry.

### 8.4.2 Employment

Statoil already has an internal policy that promotes the hiring of qualified local staff at various positions. However, the shortfalls of employment are mostly related to Tanzanians not being employed in offshore activities. COWI suggest that this may be enhanced by having certain sea service courses sponsored as part of company's Corporate Social Responsibility to enable Tanzanians to get the appropriate skill set for various positions on supply vessels.

The current agreement with the contractor for the supply vessels is valid for another 12 months. Statoil Tanzania has yet no requirements for recruiting nationals on supply vessels. However, once the contract will be updated or a new contract in place, the issue with local content will be addressed early on with the clear objective of employing local Tanzanians onboard these vessels.

### 8.4.3 Health and Safety Risks

Statoil already has an HSE policy, procedures and training program. This includes the provision of PPEs; appropriate signage of dangers and cautions; adequate labelling of hazardous materials; and procedures for the storage and handling of hazardous materials. This is the same for MUFA at Mtwara Port Base. Furthermore, Statoil's health and safety record is good, with no major incidents

recorded since their operations in Tanzania. This can be maintained by ensuring that:

- › New personnel have a rigorous Health and Safety induction on sources of risk, procedures, and emergency response actions;
- › Regular drills and exercises to keep personnel alert of health and safety risks;
- › All contractors adhere to national TBS standards related to water quality, emissions to air and ambient noise levels;
- › Statoil's emergency response plans are updated with national standards and the NMOSRCP (when it is approved) and
- › Social cohesion and communicable diseases

For new personnel, foreigners or from other parts of Tanzania, the following measures should be taken to minimize the impact of communicable diseases:

- › Health and Safety induction of personnel on understanding social conduct codes based on cultural characteristics of the resident population, of local culture and costumes and of the importance of respectful social relationships with the local community.
- › Disciplinary measures in personnel contracts of employment regarding the unruly behaviour and possession and consumption of intoxication substances while on duty.
- › Health and Safety induction of personnel on sexually transmitted diseases
- › Availability of confidential counselling for personnel on health related issues
- › Ensure that vessels and offices at Mtwara Port Base have essential first aid services to stabilise the sick or injured while waiting for helicopter evacuation; that has basic medicine; and malaria repellent, nets and prophylaxis are well stocked.

#### 8.4.4 Loss from collision with other marine vessels

The following measures can minimize the risk of collision between supply vessels and other vessels for fishing and tourism:

- › The use of either notices to mariners, radio communication or warning lights to alert the presence of supply vessels;
- › Supply vessels to avoid night time trips when some small vessels will not be visible.

#### 8.4.5 Piracy

Currently drill ships are accompanied by security vessels. In addition, the national navy patrols Tanzania's EEZ to monitor piracy threats. To enhance existing measures TPDC is to strengthen coordination with SUMATRA and DFSA to ensure that vessels in Tanzania's EEZ are adequately registered and equipped with VMS. This will enable the authorities to pick up on unregistered vessels and alert the navy to investigate potential threats or illegal activities.

#### 8.4.6 Blow out

The mitigating measures for combating blow outs are described in section 8.2.2 above. Specifically regarding mitigating measures for impacts on people the following measures should be implemented:

- › Prepare public relations plan that will disseminate information on positive steps and measures taken to prevent such events.
- › In the event of a blowout, public relation campaign to manage public's perception and disseminates information of positive steps taken to restore the environment.

## 9 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

### 9.1 Introduction

The objective of an Environmental and Social Management Plan (ESMaP) is to provide the delivery mechanism for the commitments made in this EIS report. To assist Statoil in implementing these recommendations, they have been brought together as a register of actions and management plans within this outline ESMaP. The aims of the ESMaP are:

- › To ensure continuing compliance with legal requirements and Statoil policies/ Health, Safety and Environment (HSE) principles;
- › To provide the initial mechanism for ensuring that measures identified in the EIS report to mitigate potentially adverse impacts are implemented;
- › To provide a framework for mitigating impacts during project execution;
- › To provide assurance to regulators and stakeholders that their requirements with respect to environmental performance will be met;

### 9.2 Statoil's HSE Principles

The HSE management system is an integral part of the Statoil total management system (See Appendix 2). Statoil's aim is to have zero impact on the environment.

Key environmental principles include:

- › Acting according to the precautionary principle;
- › Assessing all relevant environmental and social issues and minimizing negative impact on the environment;
- › Complying with applicable legislations and regulations;

- › Setting specific targets and improvement measures based on relevant knowledge of the affected area;
- › Consulting and cooperating with relevant stakeholders;
- › Working actively to limit the effects of fossil fuels on climate change by addressing energy efficiency, emissions trading, etc.;
- › Seeking to maintain biodiversity and key ecosystem functions and values; and
- › Minimising the generation of waste.

The exploration drilling program for Block 2 will be conducted in line with Statoil's HSE management system.

### 9.3 Environmental and Social Management Plan

Statoil shall implement the ESMaP through its own personnel or through provision of necessary supervisory oversight to ensure mitigation measures are implemented and monitoring undertaken of all components implemented by contractors.

Statoil has extensive previous history of exploration drilling in conditions similar to those experienced at the Block 2 location. A programme of this scale will be guided by specific management requirements that will be incorporated into the overall implementation strategy for the project via, but not limited to, the following:

- › The pre-tender qualification includes HSE aspects and agreement on environmental conditions and/standards;
- › HSE procedures agreed with contractors (i.e. inclusion of environmental conditions and/standards) are contractually binding;
- › Direct project supervision on site through presence of Statoil Drilling supervisor at the drill ship;
- › Regular review and/or audit with and reporting of environmental performance/improvement of implementation;
- › A project specific-work plan (see ESMaP Table 9-1 to Table 9-4) to include the following guidelines or manuals:
  - › Emergency Response Plan (ERP) (presented in Appendix 3);
  - › Waste Management Plan for drill ship (Appendix 4.1)
  - › Waste Management Plan for Mdenge waste management site (Appendix 4.2);

- › Health and Safety Plan (included in ERP in Appendix 3 and outline of principles in Appendix 2 and
- › Oil Spill Response Plan (OSRP) (not relevant for those wells that will be classified as gas wells).

In the EIS the environmental risk assessment it was found that the unlikely event of an uncontrolled blow-out of gas or oil may potentially cause "*moderate*" to "*major*" impacts if not mitigated:

Accidental spills of diesel or drilling muds from drill ship or supply vessel may cause "*moderate*" impact on some organisms and ecosystems if not mitigated.

All other potential impacts were assessed as being "*insignificant*" or in a few cases "*minor*"

Some of these impacts are "*insignificant*" or "*minor*" because mitigating measures are already in place in current operations. This is the case for:

- › Environmental risks related to discharge of ballast water from ships that has arrived from outside the East African Region;
- › Disruption of coastal fisheries due to damaged nets from supply vessels;
- › Discharge of cuttings;
- › Waste disposal and
- › Health and Safety (H&S)

However close management is required to maintain the risk of impacts as "*insignificant*" or "*minor*". Therefore management and mitigation measures for these potential impacts are included in the ESMaP.

The ESMaP for the exploration drilling in Block2 are outlined in Table 9-1 to Table 9-4 below.

#### Costs

The mitigating measures are considered part of Statoil's operational activities. Therefore the costs for implementing the mitigating measures is included in the estimated investment cost for each well (Cf. Chapter 11.1.1)

Table 9-1 Statoil ESMaP for potential impacts of accidental spills and blow-outs caused by proposed additional drilling

Impact		Mitigation and Management Actions	Phase	Target / Standard	Responsibility	Costs
1	Contamination on marine and coastal ecosystems due to potential accidental major spills of diesel	Detailed in Statoil ERP (Cf. Appendix 3)	Mobilization Operation Demobilization	Marpol NOSRCP (when approved) National Environmental Management Act (EMA) and its regulations	Statoil Project Team in collaboration with the National Marine Oil Spill Coordinating Committee	3,000 - 4,000 USD per tonnes spilled
2	Impact on marine waters due to accidental gas blow out	Detailed in Statoil ERP ( Cf. Appendix 3)	Operation	Marpol	Statoil Project Team with the National Marine Oil Spill Coordinating Committee	500-1000 USD per tonnes spilled
3	Impact on marine and coastal ecosystems due to accidental oil blow out	Detailed in Statoil OSRP if probability of oil well is more than 1% (Cf. Appendix 7.2)	Operation	NOSRCP (when approved) Environmental Management Act (EMA)	Statoil Project Team with the National Marine Oil Spill Coordinating Committee	3,000 - 25,000 USD per tonnes spilled

Table 9-2 Statoil ESMaP for potential impacts caused by discharge of ballast water, disruption of coastal fisheries and discharge of cuttings during proposed additional drilling

Impact		Mitigation and Management Actions	Phase	Target / Standard	Responsibility	Costs per well
4	Impact on coastal economic activities due to potential accidental oil blow out	Detailed in Statoil OSRP if probability of oil well is more than 1% (Cf. Appendix 7.2)	Operation	NOSRCP (when approved) Environmental Management Act (EMA)	Statoil Project Team with the National Marine Oil Spill Coordinating Committee	Included in costs in 3 above
5	Risk of introduction of alien invasive species due to discharge of ballast water from ships that arrive from outside East Africa Not Applicable for Discoverer Americas that will drill the Mronge well and which arrive from Mozambique	Ballast Water Management Plan	Mobilization	Marpol	Drill ship and supply vessels contractors supervised by Statoil Project Team	Ca. 1000 USD
		Actions on board drill ship: <ul style="list-style-type: none"> <li>&gt; Precautionary practices during intake of ballast water</li> <li>&gt; Ballast Water exchange</li> </ul>			Drill ship and supply vessel contractors, supervised by Statoil	Ca 500 USD per well
6	Adverse impact on water quality and seabed fauna communities due to discharge of cuttings and adhered SOBM components	<ul style="list-style-type: none"> <li>&gt; Use a SOBM formulated with an internationally acceptable and proven low toxicity</li> <li>&gt; Use a closed circulating system to recycle SOBM throughout drilling.</li> <li>&gt; Minimize oil on cuttings to &lt; 6.9 % through processing by on board solids control system</li> <li>&gt; Ensure that equipment works at maximum efficiency (shakers and centrifuges combined with cuttings dryer) so best performance can be achieved.</li> </ul>	Operation	Marpol IFC standard	Drill ship contractor/mud contractor  Supervised by Statoil Project Team	Included in operational costs

		<ul style="list-style-type: none"><li>&gt; No discharge of whole SOBMs-fluid to the sea after drilling is completed.</li><li>&gt; Potentially recycle to later operations.</li></ul>				
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Table 9-3 Statoil ESMaP for potential impacts caused by inappropriate handling, storage and disposal of waste during proposed additional drilling

Impact		Mitigation and Management Actions	Phase	Target / Standard	Responsibility	Costs
8	Environmental impacts at sea and on land due to inappropriate handling, storage and disposal of waste	<p>Waste Management Plan that include a range of disposal methods, undertaken in accordance with legislation and standards, local government authority by-laws, and international agreements, focused on three waste streams and be based on the following principles:</p> <ul style="list-style-type: none"> <li>&gt; Segregation of waste streams on board drill-ship and supply vessels.</li> <li>&gt; Recycling or reuse of waste products where possible.</li> <li>&gt; All solid wastes (apart from cuttings) returned to Mtwara Port for disposal as per agreed procedures.</li> <li>&gt; No discharge of solid wastes overboard (except for cuttings).</li> <li>&gt; Ensure cutting shakers and separation equipment continuously monitored and cleared to avoid blockage.</li> <li>&gt; Institute continuous monitoring of SOBMs fluid recovery performance</li> <li>&gt; Maintain daily records of drilling wastes, e.g. through a Drilling Environmental Discharge Report (part of Waste Management Plan).</li> <li>&gt; Treat slop water before discharge</li> <li>&gt; Ensure recovered oil returned to shore for treatment recycling or appropriate disposal.</li> <li>&gt; Treat waste oily water to hydrocarbon levels</li> </ul>	Mobilization, Operation, Demobilization	<p>Discharges at sea as per MARPOL 73/78 Annex 1 requirements)</p> <p>Discharges and disposal on land as per EMA regulations</p>	Waste Management and Drill ship Contractors supervised by Statoil Project Team.	12,000 USD per day

		<p>less than 29 ppm prior to discharge</p> <ul style="list-style-type: none"> <li>&gt; All potentially hazardous waste, oils or chemicals used to be handled (on drill ship and supply vessels) in accordance with their MSDS held on site.</li> <li>&gt; Hazardous materials are segregated into clearly marked containers, documented and stored securely, awaiting shipment ashore for disposal.</li> <li>&gt; Maceration of sewage waste to &lt; 25 mm prior to discharge.</li> <li>&gt; Solid wastes such as glass, paper, plastic and cans segregated using clearly marked bins for correct on-shore disposal/recycling, for on-shore disposal (as per Statoil Waste Management Plan).</li> <li>&gt; Records off all waste maintained and updated routinely.</li> <li>&gt; Communication and information sharing with Local Government Authority and local community</li> </ul> <p>Cf Appendix 4.1 (Transocean waste management plan) and Appendix 4.2 (SBS waste management plan)</p>				
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Table 9-4 Statoil ESMaP for Health and safety risks during proposed additional drilling

Impact		Mitigation and Management Actions	Phase	Target / Standard	Responsibility	Costs
9	Health and safety risks	<p>Statoil shall ensure adherence to an Occupational Health and Safety Plan for drill ship, vessels and Mtwara Port and that inspections/audits are conducted to eliminate and/or reduce impacts to project personnel, plus measures related to the following:</p> <ul style="list-style-type: none"> <li>&gt; Install a code of practices at work place including Health and Safety training, emergency test exercises and disciplinary actions</li> <li>&gt; Provision and use of Personal Protective Equipment (PPE)</li> <li>&gt; Ensuring working conditions adhere to TBS and OSHA requirements</li> <li>&gt; Provision of first aid and other medical facilities</li> <li>&gt; Reduce faulty equipment and risky practices</li> <li>&gt; Manage water and sanitation</li> <li>&gt; Implement the ERP</li> </ul> <p>Cf. Appendix 3</p>	Mobilization, Operation, Demobilization	<p>TBS requirements on noise and air</p> <p>OSHA requirements on working conditions</p>	Statoil Project Team in collaboration with Waste Management and Drill ship Contractors	Included in operational costs

## 9.4 Roles and responsibilities

HSE is a line responsibility. However the ultimate responsibility for HSE performance of the Project lies with Statoil. In the daily operations the HSE-responsibility lies within the contractor. Statoil will however have responsibility for monitoring the performance of the contractor and also the overall Project according to this ESMP and any relevant national regulations.

### 9.4.1 Role of Statoil organisation

Key Statoil staff involved in HSE management includes:

#### Drilling team

- › **Drilling Superintendent**- Is overall responsible for ensuring that the operations on the allocated drilling rig are planned and implemented in accordance with Statoil governing documents, goals and strategies, as well as statutory and regulatory requirements.
- › **Drilling Supervisor** – Is responsible for ensuring that the operations on the drilling rig and at the rig site are planned and implemented in accordance with Statoil governing documents, goals and strategies, as well as statutory and regulatory requirements. The drilling supervisor has a “see to” responsibility related to execution phase for the entire installation on floating units as well as areas, activities and equipment related to drilling and well on mobile drilling units.
- › **Drilling engineer** -Is responsible for planning and design work related to the planned operations.
- › **HSE-engineer** - Is the position that will follow up the HSE-performance at the drill ship and stay in contact with the HSE-officer on board the drill ship

#### Dar office

- › **Country Manager**- Has overall responsibility for all activities in Tanzania. In particular, the country manager will establish the Statoil Tanzania Line 2 emergency organisation for supporting the on and offshore operations and further also the naval security for the offshore operations. For assuring performance of operations the country manager can initiate HSE audits.
- › **Safety Manager** - based in the Dar office will on behalf of the country manager, follow up the safety, working environment and security issues related to all Statoil project activities in Tanzania and monitors these issues for all contractors except for the drilling contractor which is directly monitored by the drilling team.

- › **Sustainability Manager** - based in the Dar office will on behalf of the country manager, follow up the environmental and social issues related to all Statoil project activities in Tanzania and monitor these issues for all contractors except for the drilling contractor which is directly monitored by the drilling team.
- › **Statoil's representative at the Mtwara Base** - will follow up and monitor the overall daily HSE-performance of the base contractor and the waste management contractor. Will stay in contact with both Safety and Sustainability Manager in Dar office.

#### 9.4.2 Responsibilities the drill ship contractor

The drill ship contractor is responsible for ensuring compliance with all relevant legislation and relevant requirements as specified by Statoil

This includes:

- › Reporting any spills or identified impacts to Statoil immediately and assisting in developing and implementing subsequent mitigation actions;
- › Managing materials, fuels, chemicals, wastes, wastewater and equipment etc. on the drill ship so as to prevent contamination of the marine environment or the generation of excessive air emissions, debris, waste, sediment, or noise;
- › Managing, preventing and developing emergency plans in case of any accident or emergency; and
- › Passing relevant requirements to sub-contractors and services providers and monitoring and enforcing their implementation.

The following personnel on the drill ship are responsible for the implementation of these procedures and measures

- › **Offshore Installation Manager (OIM)** - will have overall responsibility for onsite decisions and operations and regularly report directly to Statoil drilling supervisor, adherence to contractor guidelines and manuals, and have authority over safety of the drill-ship and personnel aboard. The OIM will furthermore be responsible for implementing the drill-ship HSE programme, and ensuring all emergency drills are conducted on schedule;
- › **HSE-officer** - will follow up the daily HSE-performance and present this to the Statoil drilling team in the daily reports and morning meetings.

#### 9.4.3 Responsibilities of the supply/security vessel contractor

The supply/security vessel contractors are responsible for all HSE issues on the supply vessels and the security vessels respectively. This includes:

- › Ensuring that HSE procedures are implemented on the vessels according to Statoil and national requirements
- › Reporting any spills or identified impacts to Statoil immediately
- › Managing materials, fuels, chemicals, wastes, wastewater and fluids transported to and from the drill ship so as to prevent accidents

The supply/security vessel contractor is also responsible for adhering to Tanzania's national requirements for the registration of vessels, acquiring permits that may be required from SUMATRA and communicating with SUMATRA and Tanzania Ports Authority where applicable.

#### 9.4.4 Responsibilities of the Base logistics Contractor

The logistics base operation company ensures that all HSE procedures are being applied at the Supply Base for work performed under that contract. They are thus responsible for the day to day implementation of HSE issues incl. necessary training of workers; coordinates actions required for the Waste Management; coordinates transport and logistics to the drill-ship; and acts as the base logistics coordinator during emergencies. Statoil has a representative at the base responsible for monitoring the performance of the base logistic company.

- **Supply Base Manager** - is the overall responsible for all HSE-activities related to logistic operations for Statoil in Mtwara.

- **HSE-manager** - will follow up and oversee the daily HSE-performance and ensure that all reporting to Statoil is done. Participate in daily meetings with Statoil's representative at the base and report the daily HSE-performance. Follow up the Mdenga Waste Management site (as long as the logistic contractor and the waste management contractor is the same company as today)

#### 9.4.5 Responsibilities of the waste management contractor

The waste management contractor is responsible for the onshore treatment and management of all Statoil's drilling related wastes. The contractor is also responsible for:

- › Communication and information sharing with local government authority and local community
- › Acquiring relevant permits from the local government authority and NEMC for the disposal of treated waste

Managing the waste in accordance with the waste management plan including the safe operation of the waste treatment facility at Mdenga.

## 10 ENVIRONMENTAL AND SOCIAL MONITORING AND AUDIT PLAN

### 10.1 Inspections and Audits/verifications

Regular audits/verifications shall be undertaken throughout the execution of the Project. The objectives of these are to:

- › Check that practices conform with planned arrangements including implementation of mitigation and management measures and compliance with legal and project commitments;
- › Identify where existing planned arrangements (e.g. measures outlined in the ESMaP) do not meet the needs or can be improved; and
- › Establish information which can be used by management to continuously improve performance.

Two types of audits/verifications shall be undertaken:

- › Periodic audits by Statoil, but frequency based on needs ; and
- › Ad-hoc audits by Statoil; in response to accidental events.

#### 10.1.1 Daily follow up

On site follow up shall be conducted by the drill ship operator on a daily basis. All results shall be documented and submitted to Statoil in daily report

#### 10.1.2 Audits/verifications

Internal audits shall be conducted by Statoil periodically based on the need identified during performance. (These shall be based on reports from the waste management, supply vessel and drill ship contractors). All results of audits shall be documented and retained. Instances of non-conformances shall be reported to the

relevant Supervisors to ensure that appropriate corrective and/or preventive action is taken.

### 10.1.3 Ad-hoc Audits/verifications

These shall be triggered by an incident and will specifically seek to understand the cause of the incident and identify a solution.

### 10.1.4 Audit Reporting

All audit findings shall be reviewed by Statoil and where corrective actions are deemed necessary, specific plans (with designated responsibility and timing) shall be developed aimed at addressing the specific finding, any underlying issues and ultimately achieving continuous improvement in performance.

### 10.1.5 Monitoring

The day to day monitoring of HSE issues during operations is to be conducted by the Contractor's respective HSE officer(s). Statoil has more of a supervisory and audit/control responsibility to ensure that HSE procedures and standards are being kept. Detailed monitoring during accidental spill and blow outs are part of the ERP (Appendix 3) and the OSRP where applicable.

The Planned monitoring activities are outlined in Table 10-1.

Table 10-1 Environmental and social monitoring to be carried out during the project

Potential impacts		Monitoring						
No	Description	Parameter	Monitoring Frequency	Monitoring site	Measurement Unit / Method	Target Level/Standard	Responsibility for Monitoring	Costs
1	Accidental Events	Maintenance of a log of non-routine events, spills and accidents The necessary root cause analysis will be undertaken.	Throughout drilling operations	On drill ship, supply/security vessels, Mtwara base and Mdenge waste management site	Number of incidents	Zero recorded incidents	Drill ship Contractor Supply/Security Vessel Contractors Logistic/Base contractor Waste Management Contractor Statoil	50,000 USD per well
2	Environmental impacts on water quality due to discharge of slop water from drill ship	Concentration of hydrocarbons in discharged slop water from the drill ship	Daily	At outlet from Slop Treatment Unit on drill ship	mg/l	Statoil internal standard/OSPAR standard for produced water < 29 mg/l hydrocarbons	Drill ship Contractor supervised by Statoil	Included in waste management costs (Cf. impact No 8 in Table 9-4)
3	Environmental impacts due to discharge of oil on cuttings from drill ship	Percentage of hydrocarbons on treated cuttings	Daily	On drill ship	Percentage	< 6.9 % oil on cuttings	Drill ship Contractor supervised by Statoil	Included in waste management costs (Cf. impact No 8 in Table 9-4)

Table 10-2 Environmental and social monitoring to be carried out during the project.

Potential impacts		Monitoring						
No	Description	Parameter	Monitoring Frequency	Monitoring site	Measure-ment Unit / Method	Target Level/Stan-dard	Responsibi-lity for Monitoring	Costs
4	Environmental impact on seabed and seabed fauna due to discharge of cuttings	Seabed Sediments/ Benthic Communities SERPENT studies on abundance of benthic fauna and the distribution of cuttings around the well site are not planned for the next drilling operations in the Sea Gap area as this is expected to be similar to the Zafarani and Lavani sites previously studied. For the drilling in Davie Ridge or West Side SERPENT studies or similar will be considered.	Once	At drilling site	Visual inspection by using ROV. Samples for analysing sea bed biology and chemistry. Disturbance analysis (Type and number of benthic species area of seabed disturbed by cuttings)	As minimum impacts as possible	Statoil	100,000 USD

Table 10-3 Environmental and social monitoring to be carried out during the project.

Potential impacts		Monitoring						
No	Description	Parameter	Monitoring Frequency	Monitoring site	Measurement Unit / Method	Target Level/Standard	Responsibility for Monitoring	Costs
5	Environmental impacts at sea and on land due to inappropriate handling, storage and disposal of waste	Manifest showing waste volumes for the different waste categories produced and handed over to the waste management contractor	Regularly	Drill ship Supply vessel Security vessels Base activities Statoil Residence in Mtwara	m <sup>3</sup> and or MT	Ensure proper segregation, safe storage and transport to Mdenga waste management site	Drill ship Contractor. Supply and security vessel and supervised by Statoil	Included in waste management costs (Cf. impact No 8 in Table 9-4)
		Waste Processing Report	Weekly	Mdenga Waste Management Site	Volume or weight	Volumes of waste processed at site or delivered to subcontractor Remaining waste at site	Waste Management Contractor	Included in waste management costs (Cf. impact No 8 in Table 9-4)

Table 10-4 Environmental and social monitoring to be carried out during the project

Potential impacts		Monitoring						
No	Description	Parameter	Monitoring Frequency	Monitoring site	Measurement Unit / Method	Target Level/Standard	Responsibility for Monitoring	Costs
6	Environmental impacts on water quality due to discharge from slop unit at Mdenge waste management site	Concentration of hydrocarbons	Regularly (according to discharge permit)	At outlet from Slop Treatment Unit on Mdenge waste management site dumped offshore according to NEMC permit	mg/l	Marpol	Waste Management Contractor monitored by Statoils	Included in waste management costs (Cf. impact No 8 in Table 9-4)
7	Damage and interruption to fishers and shipping	Establish a grievance register of reported complaints from fishers, shipping or other users of the area	Throughout drilling operations	At drill ship and supply/security vessels	Number of reported damages/complaints	Zero recorded incidents	Statoil	200-500 USD per well
8	Health and safety risks	Register/log of incidents affecting the health and safety of workers e.g. injuries, causes, casualties, equipment faults etc.	Throughout drilling operations	At drill ship. supply/security vessels and Mtwara Port Base	Number of reported incidents	Minimum reported incidents	Contractors supervised by Statoil	Included in Health and safety risk management costs (Cf. impact No 9 in Table 9-4)

## 11 COST BENEFIT ANALYSIS

A cost-benefit analysis is more often conducted as part of a feasibility study that incorporates the environmental, social, and economic costs and benefits of a particular undertaking. The aim is to inform the proponent and the environmental authorities of the main environmental and socio-economic costs to weigh in decision making.

### 11.1 Overall cost implications

The costs of the additional exploration drillings include the actual investment cost, the costs on the environment and the socio-economic costs.

#### 11.1.1 Investment costs

Preliminary estimates of each well in Block 2 are of the order of US Dollars 130-150 million. This includes:

- › Expenditure on materials and equipment,
- › Operational and maintenance costs (for drill ship, supply vessels, security vessels, helicopter and office),
- › Personnel costs (employed staff and consultants) and
- › Health, Safety and Environment management.

#### 11.1.2 Environmental costs

The main environmental costs are related to moderate and large impacts identified in chapter 7. These impacts are primarily a result of the risk related to a potential release of ballast water during the mobilisation of the ships, the accidental leakages or spills during operation and accidental blow outs. The monetary costs of such impacts are difficult to quantify depending on the costs to clean up pollution.

### 11.1.3 Socio-economic costs

The social costs of potential impacts during planned operations are negligible. The financial resources needed to mitigate the impacts from planned activities are minimal in comparison to the investment costs. Large socio-economic costs are only expected if an accidental blow out or spillage occurs. These costs will be related to

- › Impacts on economic activities such as fisheries, tourism and shipping,
- › Injury or more severe fatalities to crew and compensation to be paid,
- › The economic cost of operational down time depending the severity of the damage to the vessel(s),
- › Any damages to the drill ship or supply vessels caused by immense pressure or fire that have to be repaired or re-built.

## 11.2 Overall potential benefits

### 11.2.1 Environmental benefits

Statoil have already invested in surveys and studies (example SERPENT-surveys and TanSEA) that have provided valuable information on Tanzania's coastal and marine environment and geology. This information is not only beneficial for Statoil but has been made available to others (BG, Petrobras) to improve environmental management and monitoring of sensitive areas.

### 11.2.2 Socio-economic benefits

The immediate socio-economic benefit from additional exploration drillings is employment and the procurement of local supplies and services. This will contribute positively to the local economy in Mtwara and Tanzania as a whole.

The long term benefits to the country are the development of discovered gas into energy. The availability of gas for energy will have a multiplier effect in the growth of industry. Furthermore, the government will also earn income from any gas exported to other countries.

## 12 DECOMMISSIONING PLAN

The EMA of 2004 requires that the proponent or operator shall undertake safe decommissioning, site rehabilitation and ecosystem restoration required before the closure of the project, at own cost.

Drilling will cease when the well target depth (TD) is reached. The well will be logged and possible coring undertaken. Irrespective of whether any hydrocarbon sources are discovered, the well will be plugged and abandoned, a process that involves cement plugs set across all reservoir sections. All wells will be permanently plugged and abandoned. However, the abandonment procedure will allow for re-entry to conduct a “drill stem test” if necessary.

In some instances the wells may be temporarily plugged for later re-entering and conversion to production wells.

The BOP will be removed but the wellhead will remain on the sea floor.

After completion of the abandonment procedures, the remote-control operated vehicle (ROV) will survey the seafloor to record the characteristics of the well location and make sure that no unnecessary structure from the drilling and abandonment activity is left behind.

When the drill ship and supply vessels tasks are completed, the drill ship will leave the location and all vessel transport related to the drilling will cease.

## 13 SUMMARY AND CONCLUSIONS

### Impacts

The environmental- and socio-economic impacts or issues of the planned exploration drilling operations and drill stem testing in Block 2 have been assessed and described in detail in this EIS. The approach examined all project phases from site selection to decommissioning.

Assessment of environmental impact significance

An assessment of the significance of environmental impacts during the site selection and design phase, the mobilization phase, the operation (well drilling) phase and the decommissioning phase found that

- › Most impacts of planned normal operations were assessed to be "*insignificant*". A few of the planned operations were assessed to cause "*minor*" impacts.
- › The impacts of unplanned events/accidents may be more severe. It was found that:
  - › The potentially most severe impacts are impacts in connection with the unlikely event of a blow out of oil which is assessed potentially to cause "*major impact*" on most environmental and socio-economic features.
  - › Accidental spills of diesel from drill ship or supply vessels may potentially cause "*moderate*" impacts on some marine organisms and ecosystems;
  - › Blow-out of gas has been assessed potentially to cause "*moderate*" to "*major*" impacts on some marine organisms and ecosystems.

Environmental risk assessment

An environmental risk assessment found that the environmental and socio-economic risks of all planned normal operations will be "*negligible*" on environmental features that may be affected. Environmental risks of unplanned events/accidents range from "*negligible risk*" to "*minor risk*" for those features that may be affected. The potentially largest risks are impacts in connection with the unlikely event of a blow out or large accidental spills of diesel. However, the risks

are only assessed to be within the range "*negligible risk*" to "*minor risk*" on those features that may be affected. Mitigating measures will be taken to reduce this risk further.

The planned operations during the drilling and Drill Stem Test operations will not contribute to measurable or observable cumulative effects.

### 13.1.1 Environmental and socio-economic impact significance

The exploration drilling activities have been classified in positive impacts and adverse impacts. Using various criteria the significance of adverse environmental and socioeconomic impacts were grouped in the following categories:

- › i) no impact
- › ii) insignificant impact,
- › iii) minor impact
- › iii) moderate impact and
- › iv) major impact.

Impacts were assessed for each of the four project phases:

- › The site selection and design phase;
- › The mobilization/site preparation phase;
- › The operation (well-drilling and drill stem test) phase and
- › The decommissioning phase.

Planned normal operations

Most impacts of planned normal operations were assessed to be "*insignificant*". A few of the planned operations were assessed to cause "*minor*" impacts.

Unplanned events or accidents

The impacts of unplanned events/accidents may be more severe. The impact analysis showed that:

- › The potentially most severe impacts are impacts in connection with the unlikely event of a blow out of oil which is assessed potentially to cause "*major impact*" on most environmental and socio-economic features. However, the wells drilled so far at Block 2 have only proved gas. This also applies for all other offshore wells drilled offshore in Tanzania. The first well drilled by Statoil (Zafarani 1) could though potentially have oil, and the EIS for the Zafarani-structure thus included an Oil Spill Response Plan. No oil is expected for the coming wells to be drilled in Block 2. If analysis for any future wells indicates more than 1% probability for oil, an OSRP for that well will be

established including necessary oil spill equipment. In that case, NEMC and SUMATRA will be notified and involved to the degree deemed necessary. Although the future wells are not expected to include any oil, a general discussion about oil spills from blow-out are included in this EIS as the scenario cannot be completely ruled out for prospects on the not yet explored areas as Davie Ridge and West Side.

- › Accidental spills of diesel from drill ship or supply vessels may potentially cause "*moderate*" impacts on some marine organisms and ecosystems;
- › Blow-out of gas has been assessed potentially to cause "*moderate*" to major impacts on some marine organisms and ecosystems.

### 13.1.2 Environmental risk

By environmental- and socio-economic risk is understood the combination of the significance of an impact and the probability that an impact actually may occur. Using various criteria environmental risks have been grouped in the following categories:

- › i) no risk ,
- › ii) negligible risk,
- › iii) low risk,
- › iv) significant risk and
- › v) high risk.

Environmental risks Impacts were assessed for each of the four project phases:

Planned normal operations

The environmental risks of all planned normal operations are "*negligible*" on environmental features that may be affected.

Unplanned events or accidents

Environmental risks of unplanned events/accidents range from "*negligible risk*" to "*minor risk*" for those features that may be affected. The environmental risk assessment has shown that the potentially largest risks are impacts in connection with the unlikely event of a blow out or large accidental spills of diesel.

#### Environmental conditions

The exploration area in Block 2 is distant from socially, economically and from a conservation perspective sensitive and important environmental resources of Tanzanian coastal areas.

Surface waters

There is a summer bloom of phytoplankton in the Block 2 area caused by the upwelling of nutrients from the deep, which forms the basis of production of zooplankton and pelagic fish species including commercially important tuna species. Endangered marine turtles listed on the IUCN Red list including

Loggerhead-, Olive Ridley-, Leatherback-, Green- and Hawksbill Turtles may occasionally pass through Block 2. This also goes for dolphins and whales, which are listed as vulnerable on the IUCN Red List. Very few seabirds are observed in the area.

Seabed environment

The seabed environment in Block 2, with water depths mainly ranging between 1700 and 3300 m, is typical of deepwater ecosystems around the world - completely dark and very cold, with temperatures about 2-5 °C. There is no visible light at depths below 200 m and below 1000 m depth all traces of light are absorbed. Consequently, no photosynthesis takes place on the seabed in Block 2. The deep ocean floor is therefore food limited and the only input of food and energy for the deep sea organisms is dead phytoplankton and their consumers from the surface waters resulting in relatively low abundance of deep sea organisms compared to shallower waters. However, the diversity of life in the deep sea can be extremely high. The deep sea megafauna in the area is dominated by xenophytophores, echinoderms and sponges (Porifera). The abundance of macrofauna is rather low and includes nematode worms, snails, foraminiferans, ostracods, polychaetes, cnidarians, sponges, bivalves, crustaceans and holothurians. The meiofauna is dominated by foraminiferans and nematodes. A total of 10 different species of deep-sea benthic fish has been observed in the area.

Commercial activities in Block 2

Commercial shipping and industrial fishing use the waters in Block 2. Fishing vessels include long-liners from SE Asia and purse-seiners mainly from Spain and France. The vessels are primarily fishing for tuna. However, the numbers of vessels participating in this fishery have fallen markedly in recent years, probably due to the problems with piracy along the East African Coast.

Mitigation measures, ESMaP and monitoring

Mitigation measures for impacts have been formulated and an Environmental and Social Management Plan ESMaP has been elaborated to provide guidance in defining precisely the mitigation measures required. Designed as a tool to assist monitoring of the drilling programme, a proposed Environmental and Social Monitoring Programme is also provided, with specific parameters to be monitored and responsibilities allocated. Performance will be subject to monitoring, review and improvement, as appropriate, during operations.

Final conclusion

With the management strategies that will be employed by Statoil for the Block 2 drilling programme, any health or safety and environmental effects of the proposed exploration drillings are expected to be negligible, temporary and localised.

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# Appendix A

## NEMC Approval letter for the Terms of Reference



**NATIONAL ENVIRONMENT MANAGEMENT COUNCIL (NEMC)**  
**BARAZA LA TAIFA LA HIFADHI NA USIMAMIZI WA MAZINGIRA**

Tel Dir.: +255 22 277 4852  
 Tel +255 22 277 4889  
 Mobile: +255 713 - 608930  
 Fax: +255 22 277 4901  
 E-mail: dg@nemc.or.tz  
 Website: www.nemc.or.tz

Regent Estate / Migombani  
 Plot No 29 / 30  
 P.O.Box 63154  
 Dar es Salaam  
 Tanzania

In reply please quote:

Ref: **NEMC/489/1/Vol.1/45**

Date: **14/05/2013**

*Stateil* Tanzania ASA  
 P.O. Box 713,  
 Dar es Salaam.

**RE: SCOPING REPORT AND TERMS OF REFERENCE (TOR) FOR THE PROPOSED ADDITIONAL OFFSHORE EXPLORATION DRILLING IN BLOCK 2, TANZANIA.**

Please refer to the subject above.

I acknowledge receipt of your letter of April 25, 2013 submitted with the Scoping report and Terms of Reference (ToR) for undertaking an EIA for the aforementioned project.

The scoping report and ToR were reviewed and found to be generally adequate and therefore can guide the Environmental Impact Assessment (EIA) study for the named project. In this regard, you will be required to submit to NEMC fifteen copies of the EIS accompanied by a Non Technical Executive Summary both in Kiswahili and English as required by section 19(2) and please consult the EIA and Audit Regulations, 2005 for contents of the EIS.

However, ensure that:

- ✓ All applicable legal and policy frameworks should be identified and respective requirements addressed in the EIA.
- ✓ Detailed stakeholders consultation should be conducted from national to individual levels
- ✓ Indicate the Number of wells to be drilled within Block 2; and carry out a critical analysis of the cumulative impacts
- ✓ Indicate handling of oil spillage in case of emergence offshore and at base camp Mtwara Port.

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**All correspondence should be addressed to the Director - General**

✓ All cutting should be shipping to shore for treatment and disposition area should be known ;

✓ Indicate the onboard treatment system for cutting and indicate the capacity of oil content after treatment.

As part of the review process, a site visit will be conducted by four representatives of the Technical Advisory Committee (TAC) so as to verify the information contained in the EIA report in relation to the actual situation on site and you will be required to organize transport to and from the site. Dates for the reviews and the site visit will be arranged after you have effected payments to the Council to facilitate the review process.

In this regard, you are required to pay to the National Environment Management Council (NEMC) a total amount of **Tshs.6,359,500/=** which excludes transport cost. Attached herewith please find the budget breakdown for your reference and preparations.

In case any clarification or information is required on thus process, please contact us through 0754-046117.

Yours Sincerely,



K.P Luteganya  
**For: Director General**

CC: COWI Tanzania Ltd,  
P.O Box 1007,  
**Dar es Salaam.**